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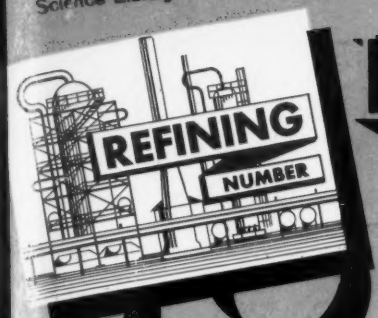

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PRICE 20 CENTS TABLE OF CONTENTS PAGE 95 **APRIL 1, 1948**

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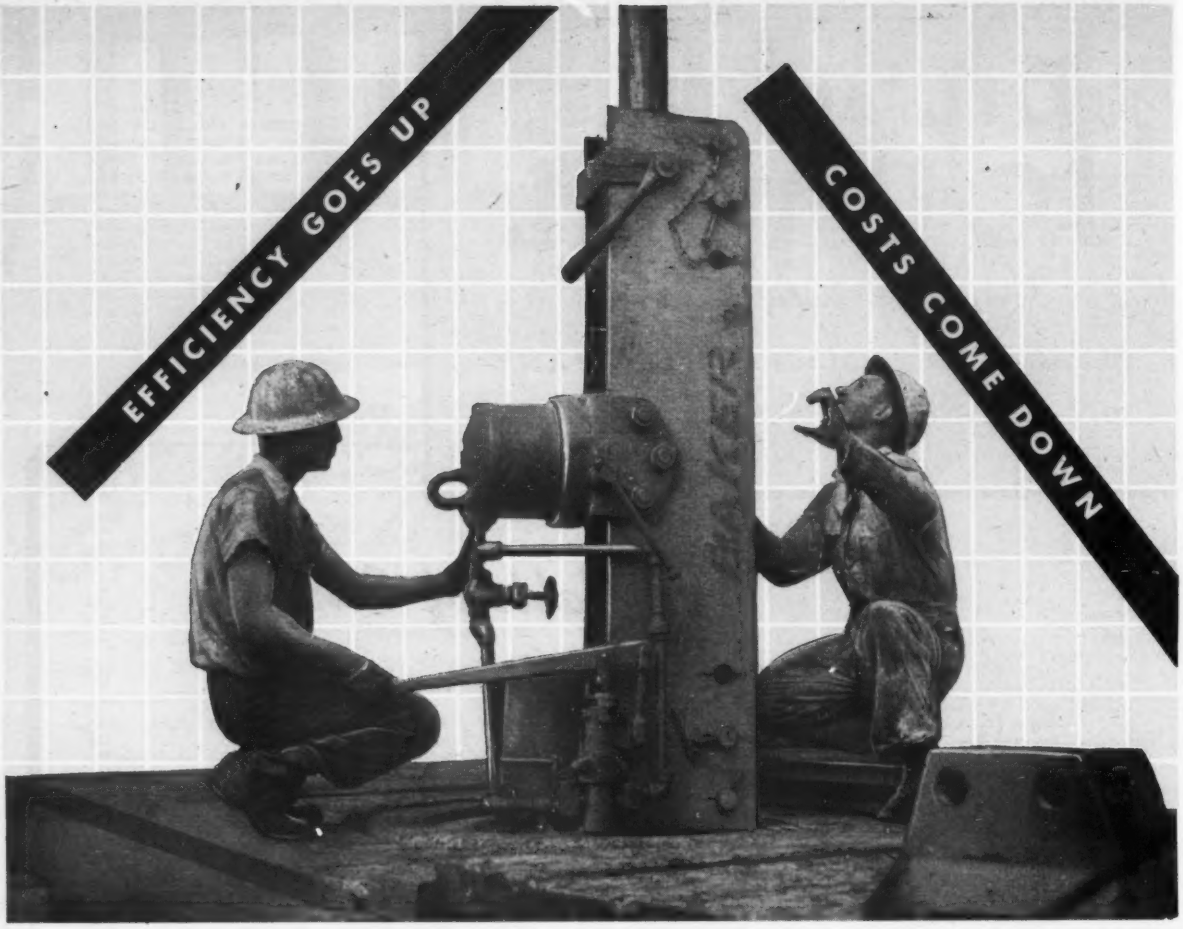

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Re Refining

THE consuming public, government officials, and many within the industry are inclined to evaluate petroleum situations solely in terms of crude-oil production and transportation. If these are available in sufficient capacity it is assumed that every other division of operations will take care of itself.

This general attitude has posed problems for the owners of 369 operating refineries in this country and approximately 250 refineries in other areas. These plant operators know that new fields, additional wells, and new pipe lines mean little until facilities are available to refine the delivered crude oil into finished products. This is the basis for refiners' contention that they are entitled to more consideration than they have been given in the allocation of steel and other materials and equipment.

During the war there was practically no expansion in refinery capacity except that required for the manufacture of war products. In the war areas many plants were wholly or partially destroyed.

Over the past 2½ years it has been possible to convert part of the emergency capacity to the refining of peacetime products but in general, refinery operations have not had the materials and manpower to modernize, rebuild, and enlarge existing plants and to install new ones where needed.

The end in improvising at refineries to satisfy unexpectedly large increases in consumption is here. The more than 150 domestic construction projects and numerous foreign programs listed in this Annual Refinery Number, must be completed as quickly as possible. Furthermore, major additional construction will be necessary over the next few years.

As revealed in the processing section of this issue refiners as a group are in a better position than ever before to do their part in supplying demands. They have the know-how to improve quality of products and expand the yields of the most essential and valuable fractions. Because construction has been delayed, through no fault of refiners, the industry and its customers have not benefited in full from new arts of petroleum refining.

As to future supplies, consumers of petroleum have no important safeguard than the refinery laboratories. Programs completed and under way, involving tens of millions of dollars in expenditures, assure that petroleum refining will lead all manufacturing in research and development work.

These laboratories are conducting investigations of immediate importance in adding to the efficiency of present-day refinery operations. Moreover, they have longer-range programs which may result in new approaches to processing operations and petrochemical manufacture, including petroleum substitutes should they be needed. It is well to keep in mind that all this is being done by private enterprise, without cost to the taxpayer.

Gas Utilities Urged to Enter L.P.G. Business by S. G. A. Speaker

by Dahl M. Duff

GALVESTON.—The natural-gas utility industry has a direct stake in ending the present "confused, chaotic, and jumbled" condition of the liquefied petroleum gas distribution business and should give consideration to actively investing and operating in the L.P.G. field.

Chester L. May, vice president of Lone Star Gas Co., Dallas, told the Fortieth Anniversary convention of the Southern Gas Association here March 26 that the natural-gas industry faces some serious and vital questions as a result of the phenomenal growth of the L.P.G. business—questions, he said, which are assuming national importance and demand an answer in the near future.

Conceivably, the number of L.P.G. users in the United States may eventually equal or even exceed the number of natural-gas consumers, May said, and the natural-gas industry has an opportunity in rendering an efficient interim fuel service through L.P.G. until it is practicable to make natural-gas service available to outlying areas.

L.P.G. Methods Criticized

"Make no mistake about it, the L.P.G. business is going to have a substantial place in the gas business in this country," he told the convention. "It does not depend on pipe lines; it can be distributed anywhere. While the supply of butane is somewhat limited, due to its value in motor-fuel blending and certain chemical manufacture, the potential production of propane is immense and the current wholesale market price for this product is encouraging the addition of equipment in many plants for its production."

May was sharply critical of the "irresponsible manner" in which some of the L.P.G. distribution business was handled during the past winter. To some extent, the field has been developed in the Southwest by merchandisers of tanks and appliances who did not assume responsibility for continuous and dependable service by the necessary planning and investment. Hundreds of distributors, May continued, sold and installed tens of thousands of butane systems with tanks far too small and then completely saturated the customer's home with gas appliances.

"Only a small per cent of these distributors provided ample bulk storage for rendering a year-round service," he declared. "As both bulk storage and the customers' tanks were under the capacity needed, many distributors were unable to secure and to deliver all the fuel required during the winter months. When their customers complained to them because they were out of fuel, the distributor usually blamed the refiner for their difficulty, when the entire trouble was of their own making."

Because of inadequate customer service by a large percentage of L.P.G. distributors, particularly where tanks are used to supply a complete fuel service for the home, the prestige of the L.P.G. business is waning in many quarters, May said. "This could have been entirely avoided, in my opinion, had the gas utilities shown proper initiative and aggressiveness, and assumed the responsibility for rendering all types of gas service in areas served by them," he said. "A constructive job by skilled and experienced gas utility people is sorely needed. . . ."

If the gas utilities do not enter the field, he continued, they should at least seek to give the benefit of their knowledge gained through long years of experience to those in the L.P.G. field who may have little or no concept of what is necessary to render an efficient and highly satisfactory service, or of the public responsibilities they assumed.

Tells Lone Star Methods

May sketched briefly the history of the L.P.G. business and described the system used by Lone Star. The company distributes butane in 250-gal. company-owned tanks. The change to larger tanks, he said, was made in 1934. One reason was the protection of its future natural-gas business in areas surrounding cities and towns. Last year, Lone Star began supplying propane in company-owned tanks. At the present time, the company is serving more than 13,000 customers, about 60 per cent using company-owned tanks, with rates comparable to natural gas at $1.50 per M.c.f. for the first 5 M.c.f. and $1.20 for all over 5 M.c.f. Average annual consumption per customer is about 750 gal.

The Lone Star Gas official spoke Friday at one of final general sessions of the 3-day meeting. Approximately 1,000 persons representing practically all branches of the gas industry—transmission, distribution, home service, sales, accounting—as well as equipment manufacturers, registered for the meeting.

The operating group, embracing the transmission and distribution sections, heard discussions of a variety of problems in this field, including

Here are the chairman of the Transmission section of the Southern Gas Association and the four-man panel which discussed pipe-line problems at the S.G.A. convention in Galveston. They are: Van Thompson, chief engineer, Southern Union Gas Co., Dallas; Landon Yauger, assistant to the general superintendent, United Gas Pipe Line Co., Shreveport; H. L. Stowers, chief engineer, Memphis Natural Gas Co., Memphis; O. H. Moore, assistant general superintendent, Tennessee Gas Transmission Co., Houston; and Carl E. Cloud, general superintendent, Oklahoma Natural Gas Co., Tulsa, transmission section chairman

telephone and radio communications, corrosion, and safety. One of the most interesting talks on the program was given at the operating group's luncheon March 25 by Dr. Paul C. Aebersold, 33-year-old chief of the isotopes division, Oak Ridge Operations, Atomic Energy Commission.

Isotope Uses Described

The widening use of radioactive isotopes in the petroleum industry's industrial research was described by Aebersold who said that this development is one application of atomic energy that has already "arrived." Problems concerned with catalytic cracking, porous media, Fischer-Tropsch reactions, oil additives, well logging, lubrication, and general hydrocarbon chemistry are lending themselves to solution with radioisotope applications, he said.

There is still much to be learned about the mechanics of the Fischer-Tropsch reactions, and Carbon 14 is now being used as one of the tracers studying these processes. Information gained from these studies undoubtedly will lead to a better understanding of the most desirable conditions relative to pressure, temperature, and catalyst, Aebersold said. As for well logging, synthetic radioactive materials probably will be more versatile in their application.

One example of the potentialities of radioisotope application mentioned by Aebersold was in the field of lubrication and friction. Investigators at Massachusetts Institute of Technology, he said, have reported as little as one hundred-billionth of an ounce of metal transferred from one surface to another can be detected by the use of radioisotopes. Such sensitivity, he continued, is thousands of times greater than by previous methods. Before the war, Aebersold said, radioactive isotopes were produced by such devices as the cyclotron but in extremely small quantities and at an almost prohibitive cost. The wartime development of the chain-reacting pile revolutionized radioisotope production.

Pipe-Line Questions Debated

Several questions of interest in the pipe-line construction field were briefly discussed by a four-man panel during the single session of the association's new transmission section March 24. Among the points brought out were the following:

According to representatives of Texas Eastern Transmission Corp., it is too early yet to know exactly what the economics are in the operation of centrifugal gas compressors. Their installation by T.E.T. was made attractive by the fact that much of the existing electrical equipment was already in place due to the conversion of the existing Inch system oil stations.

Michigan-Wisconsin Pipe Line Co. is experimenting with the use of telephone cable laid alongside pipe lines. This project is being carried out between Detroit and Owasso and involves a small plastic-covered cable of about ½ in. containing four pairs of wires.

There is no hard and fast rule as to the amount of slack necessary in lines. One opinion was that "most companies put in all the slack they can get and hope it's enough."

In his report as outgoing chairman of the transmission committee, Carl E. Cloud, general superintendent, Oklahoma Natural Gas Co., Tulsa, said the year-old transmission group is planning probably two regional meetings during the coming year. One of these probably will be held in the Southeast, and the other in the Southwest. The purpose is an exchange of technical information.

A warning that adequate channels for all users of mobile radios is threatened by the now-pending House Resolution 78 was given at the transmission section by Dr. Dan Noble, vice president and director of Motorola, Inc., Chicago. There are simply not enough channels to go around, he said, and the resolution would require the Federal Communications Commission to give to the FM broadcasting group a section of the 50-megacycle band which has been earmarked for mobile users, including industrial services of all kinds as well as public services. The power and gas industries have much at stake, and the fight against the resolution needs all support possible. In his talk, Noble also described various new developments in the radio field, including telemetering, teleswitching, and a new Handitalkie set much superior to the walkietalkie used during the war.

Another talk on communications was that given by W. B. Hardin, Southwestern Bell Telephone Co. engineer, Houston. He described the Bell system's mobile telephone service introduced in June 1946 and now furnished in more than 80 cities in the United States. In addition to the general mobile service, special requirements of some customers are being met with mobile systems provided by the customer himself or leased from the telephone company.

The construction permit and operating license for private systems is issued to the customer by the FPC, but the telephone company will assist in the preparation of such applications, Hardin said. The telephone company performs all installation and maintenance work, including work requiring licensed first or second-class radio technicians. The customer operates and controls the system and is responsible for conforming to the rules and regulations of the FPC.

W. H. Ligon, president, Nashville Gas & Heating Co., Nashville, Tenn., was elected 1948 president of the association succeeding W. Lee Woodward, president, Zenith Gas System, Inc., Alva, Okla. Other new officers:

L. L. Baxter, president, Arkansas Western Gas Co., Fayetteville, Ark., association first vice president; Carl H. Horne, vice president, Alabama Gas Co., Birmingham, Ala., second vice president; Lyman L. Dyer, comptroller, Lone Star Gas Co., Dallas, treasurer; E. T. Anderson, assistant treasurer, Atlanta Gas Light Co., Atlanta, secretary; and five association directors: J. H. Schmidt, Texas representative Peerless Manufacturing Co., Dallas; A. H. Weyland, president, Arkansas-Louisiana Gas Co., Shreveport; H. K. Griffin, vice president and general manager, Mississippi Gas Co., Meridian, Miss.; John C. Flanagan, vice president, United Gas Corp., Houston; and R. F. Hinchey, president, West Texas Gas Co., Lubbock.

At the Southern Gas Association convention in Galveston: Dean Strickland, general sales manager, United Gas Corp., Houston; W. H. Ligon, president Nashville Gas & Heating Co., Nashville, new association president; and J. H. Wimberly, executive vice president, Houston Natural Gas Co., Houston, association director

Military Continues Study Into Advisability of Building Tapline

WASHINGTON.—Possibilities that the military will stand fast behind the original decision that construction of the Trans-Arabian pipe line was desirable were seen last week in postponement of a hearing by the Senate small business oil subcommittee at which Defense Secretary James V. Forrestal was to disclose his opinion as to continuance of construction of the line.

The postponement was asked by Forrestal, who on March 17 testified he had asked the Joint Chiefs of Staff to study the international situation and report their views as to whether further exports of steel for the line should be supported or a tanker construction program initiated.

Instead of appearing before the subcommittee, Forrestal testified before another committee studying universal military training, and there was no indication whether he had requested postponement of the pipe line matter because of the UMT legislation or as a result of the change in the United States' position on the partition of Palestine.

In other quarters, however, it was said that abandonment of partition might go far to "take the heat off" the Middle East situation and pave the way for the granting to Arabian American Oil Co. of a right-of-way for the pipe line from the Saudi Arabian border to the Mediterranean coast.

When Forrestal earlier last month told Sen. Kenneth S. Wherry of Nebraska that he was reviewing the situation, Commerce Department officials assured the small business subcommittee they would withhold action on the second quarter export allocation of pipe for the line, and Assistant Secretary of State Willard Thorp agreed that the pipe line should be reviewed in the light of current developments.

There has been no indication, however, that the State Department would be moved by Forrestal's recommendation alone to support a suspension of pipe exports, and in some department quarters, it is understood, it is believed too much emphasis has been placed upon the question whether the Saudi Arabian oil fields and pipe line could be protected in the event of an emergency.

Some officials are represented as feeling that to halt the pipe line now would be an admission of impotence of which Russia might seek to take advantage, developing an even more serious situation than prevails at present.

These officials take the position that a few well-placed air bases would be able to neutralize the whole Middle East oil area, and point out we already have bases within reach of the oil installations, a fact which undoubtedly has exercised a calming influence.

In view of the change in the Palestine situation, there were suggestions that Forrestal would defer the making of a final decision on the pipe line until he saw how matters were shaping up.

Freight Service Cut Exempts Oil and Fuels

WASHINGTON.—Following up a 25-per cent cut in passenger transportation by coal-burning locomotives, the Interstate Commerce Commission put into effect March 30 a similar curtailment of freight service, effective until May 1 unless earlier terminated or modified.

To insure the uninterrupted flow of necessities, the commission authorized the railroads to set up a system of priorities for specified commodities including crude petroleum, gasoline and antiknock compound, fuel oil, kerosine, lubricating oils and greases, L.P.G., and other products.

Mead Disqualifies Self For FPC Appointment

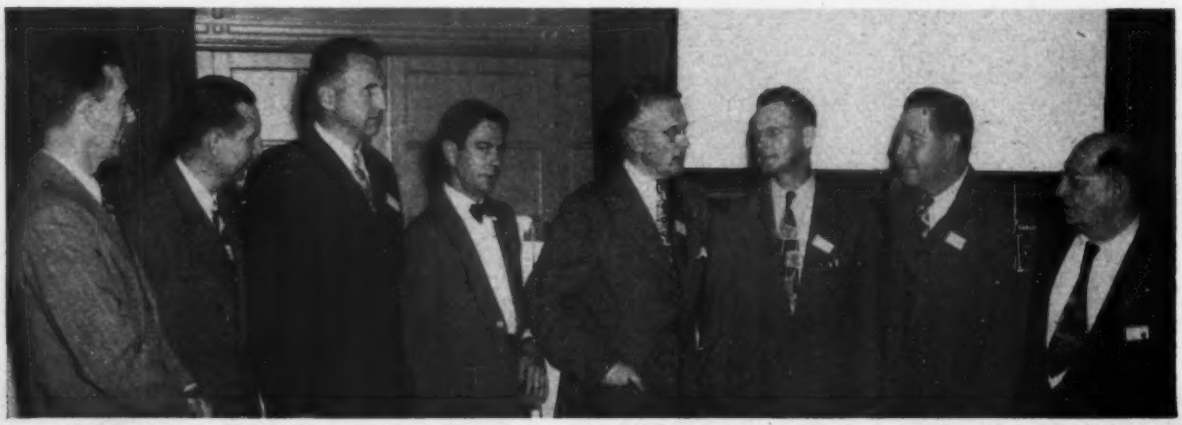
WASHINGTON.—An avowed candidate for a Government post has turned one down because of inexperience.

Former Senator James M. Mead of New York last week rated more than passing notice when he turned down a White House offer of appointment to the Federal Power Commission as a substitute for Burton N. Behling, whose nomination was withdrawn by President Truman last month.

Mead said he had been interested in appointment to one of the agencies with which he was familiar as a result of his long service in the House and Senate, and an offer of a post in the Interstate Commerce Commission, Civil Aeronautics Board, or Post Office Department would command his serious consideration.

But, he added, "I am not familiar with the problems that beset the Federal Power Commission and 'green hands' are not necessary when experienced personnel is available."

More than 350 geologists and geophysicists gathered at the Rice Hotel in Houston March 26-27 for the first closely coordinated regional meeting of the two professional societies ever held in the area. Sponsoring the conference were the Houston Geological Society and the Houston section of the Society of Exploration Geophysicists. Featured speaker was Dr. A. I. Levorsen, Stanford University, Palo Alto, Calif., who discussed "Time of Oil Accumulation." Shown here are Walter J. Osterhoudt, Gulf Research & Development Co., Houston, president of the Houston S.E.G. section; A. F. Childers, Jr., reserve geologist, Gulf Oil Corp., vice president of the Houston Geological Society; Ray C. Lewis, chief geologist, Houston Oil Co. of Texas, Houston Geological Society program chairman; W. D. Mounce, geophysical research, Humble Oil & Refining Co., Houston S.E.G. section program chairman; Levorsen; Roy L. Lay, assistant manager, geophysical division, The Texas Co., second vice president of the Houston S.E.G. section; Charles H. Sample, geologist, J. M. Huber Corp.; and Dr. Paul Weaver, chief geophysicist, Gulf Oil Corp., who is president-elect of the American Association of Petroleum Geologists



this week

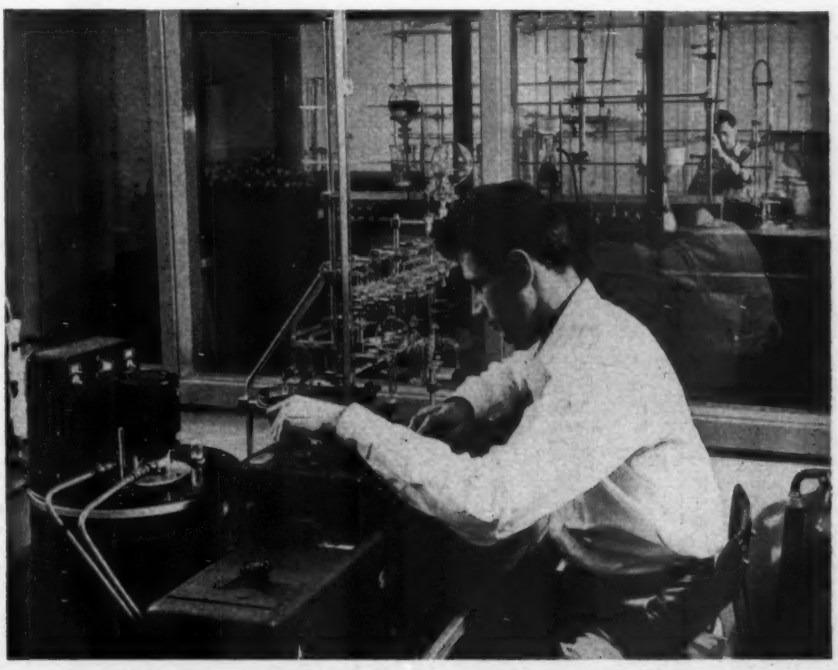
TRENDS—Gasoline stocks show gain of 1,329,000 bbl. during week ended March 20, bring stock total to 113,247,000 bbl. . . . Stocks now about 7,500,000 bbl. greater than end-of-March figure in 1947. . . . Most of increase accounted for in Texas Gulf and California. . . . Distillate and other stocks show declines, resulting in a net drop in stocks of four major products. . . . ¶Runs to stills off slightly but remain about 10 per cent above last year. . . . Louisiana refineries record highest runs of year, operating at 123 per cent of rated capacity. . . .

INTERNATIONAL—Pemex head, Bermudez, outlines expansion plans for the oil industry in Mexico. . . . Says Pemex can meet expenditures with own money plus loans already applied for. . . . Proposed sites of new facilities include Poza Rica area, the port of Guaymas, the Monterrey zone, the Guadalajara region, and Tampico. . . . ¶Report shows French refinery output for 1947 far below demand. . . . Cause is laid to lack of crude oil and strikes. . . . ¶Two French oil companies merge. . . . ¶Russian-Switzerland commercial treaty provides for exchange of Russian petroleum products for Swiss machinery. . . .

PIPE LINE—Interstate Oil Pipe Line Co. prepares to test aluminum pipe in full-scale operations. . . . Two installations will be located in areas where corrosive problem is acute. . . . Pipe will be field welded by Heliarc welding process. . . . ¶Stanolind Oil & Gas Co. begins laying 320 miles of pipe to serve plant operations in Slaughter pool near Levelland, Tex. . . . ¶Sohio Pipe Line Co. and Buckeye Pipe Line Co. begin construction of Cygnet-Cleveland, Ohio, 120-mile crude line. . . . ¶Military continues study into advisability of building trans-Arabian line. . . . Forrestal believed awaiting Middle East developments. . . .

REFINING—High compression ratios and direct fuel injection will feature engine designs of the future, speakers tell national transportation meeting of the Society of Automotive Engineers in Philadelphia, March 30-April 1. . . . ¶Construction on Shell Oil Co., Inc.'s refinery near Houston halted pending outcome of contractor-union labor dispute. . . . ¶Shell Chemical Co. begins construction of new synthetic unit at Martinez, Calif. . . . Plant will manufacture "petroleum additives." . . .

NATURAL GASOLINE—Natural-gas utility industry urged to enter L.P.G. field by Chester L. May, vice president of Lone Star Gas Co. . . . L.P.G., he said, will play a large role in the nation's gas business. . . . Utilities, he asserts, can end "confused, chaotic, and jumbled" condition in L.P.G. industry. . . . ¶Gulf Oil Corp. to build natural-gasoline plant in Crane County, Texas. . . . ¶Plans for new plants in Lincoln Parish, Louisiana, announced by Southwest Gas Producing Co. and California Co. . . . ¶Cycloversion unit added to McCarthy plant at Winnie, Tex., begins operations. . . . ¶Unprecedented demand for natural gasoline and L.P.G. reviewed at Natural Gasoline Association of America meeting. . . .



Indicative of the advance technology being introduced into the refining industry, described in this issue, the annual Refining Number of The Oil and Gas Journal, is this scene in the recently enlarged Richmond, Calif., laboratories of California Research Corp., subsidiary of Standard Oil Co. of California. A detailed article on the laboratories will appear in the April 8 issue of the Journal. The complicated instrument shown here is an infra-red spectrograph photometer, used to determine the chemical composition of a petroleum sample

New Developments in Production Highlight A. P. I. Wichita Meeting

by Leigh S. McCaslin, Jr.

WICHITA, Kans.—Discussions of recent developments in production practices, secondary recovery, and care and maintenance of oil-field equipment highlighted the spring meeting here March 24-26 of the Mid-Continent district of the American Petroleum Institute's Division of Production.

Thirteen technical papers were presented in group sessions during the 3-day meeting. A total of 565 oil men registered.

In welcoming the Texas, Oklahoma, and Kansas production men, Gov. Frank Carlson predicted that one-third more wells will be drilled in Kansas during 1948 than in the past year. Other 1948 forecasts by the governor included oil production of 105,000,000 bbl., gas production of 200 billion cubic feet, and 2,450,000 bbl. of natural gasoline, propane, and butane—all of which represent only slight increases (see accompanying table). The monetary investments being made in the state by the oil industry were emphasized with the statement that in excess of $150,000,000 would be spent in western Kansas alone in the next 2 years.

A highlight of the A.P.I. program was a talk on hydrocarbon synthesis in western Kansas by A. L. Solliday, executive vice president of Stanolind Oil & Gas Co. The paper, slightly abridged, may be found on pages 110-111 of this issue.

In addition, the membership elected a new slate of officers for 1948-49, consisting of Lloyd E. Elkins, Stanolind Oil & Gas Co., Tulsa, chairman; J. H. Field, Sohio Petroleum Co. of Oklahoma City, vice chairman for Oklahoma; Lloyd Pickrell, T. C. Johnson estate, Wichita, vice chairman for Kansas; Dallas Bowsher, Skelly Oil Co., Pampa, vice chairman for Panhandle; and Harold Berg, Tide Water Associated Oil Co., Tulsa, secretary-treasurer.

New Perforating Method

Experimental work to adapt a war-developed incendiary to oil-field use in making perforations, cutting tubular goods, and facilitating fishing jobs was described by Prof. W. L. Gilliland, Purdue University, in an address before the session on care and maintenance. Thermit, a mixture of alumina and powdered hammer scale (iron oxide), is being used as the cutting medium in a gun developed for down-hole use in wells. The incendiary was used in wartime bombings to burn out the walls of oil and water-filled storage tanks. The thermit, which produces a tremendous hot blast, is ignited by a squib which is fired by the electrical cable used to lower the gun into the hole. In some 30 tests to date, the thermit gun has been found to offer good possibilities for oil field use. A drilling contractor present, suggested that the gun might offer a solution to the problem of freeing stuck drill collars.

A 50 per cent reduction in well pulling and equipment expense, was disclosed by Walter C. Pearson, Stanolind Oil & Gas Co. engineer, reporting on that company's 3-year anti-corrosion program in Kansas. Formaldehyde was used as an inhibitor to combat hydrogen sulfide corrosion in 325 Kansas wells producing from the Arbuckle lime with a resultant average saving of $50 per well per month.

The importance of proper surface preparation before applying plastic coatings, was emphasized by manufacturers' representatives in commenting on the paper "Classification of Plastic Coatings," by J. L. Robertson, Phillips Petroleum Co. Robertson's paper was the result of interest expressed by the A.P.I. materials committee members in plastics and

Behind the scenes at the Wichita A.P.I. meeting, six committees of the Mid-Continent section gathered to plan their work for the coming year. Pictured in session (top to bottom) are the core analysis and well logging committee, R. C. Curtis, C. H. Murphy interests, chairman; secondary recovery methods committee, R. C. Earlougher, Earlougher Engineering, chairman; and drilling practice committee, Frank H. Willibrand, Sohio Petroleum Co., chairman

offered a systematic approach to the problem of selecting coatings for specific uses. Plastic coatings were classified on the basis of the family or parent material and considerable data presented on the characteristics of the many different plastics now available.

"Recent Developments in Recommended Field Practice on Care and Use of Oil Country Tubular Goods" was the subject of a paper presented by H. M. Cooley, Bethlehem Steel Co., Tulsa. The recent revision of the A.P.I. bulletin on recommended practice for tubular goods and the drill-string research by Battelle Memorial Institute for the American Association of Oilwell Drilling Contractors was discussed. Emphasis was on proper practices in running casing and in making up tubing joints. Final feature of the care and maintenance section was a color movie presented by W. E. Huddleston, Huddleston Engineering Co., Bartlesville, on "Prevention of External Pipe Corrosion Through the Use of Expendable Anodes."

Water Flooding Discussed

An estimate by A. E. Sweeney, Jr., Interstate Oil Compact Commission, Oklahoma City, that 50,000,000 bbl. of oil would ultimately be recovered by water flooding in eastern Kansas was termed "ultra-conservative" by one expert present at the secondary-recovery session. Sweeney presented a progress report on the IOCC's water-flood survey of Kansas. Annual water-flood production in Kansas has shown a rapid increase in the past 10 years and was reported as 3,632,217 bbl. from 2,571 producing wells for 1946.

An outstanding reference work on oil and gas law was the characterization given by Barth Walker, Stanolind Oil & Gas Co. attorney, to the paper "Statutes Relating to Secondary-Recovery Operations" by R. E. Hardwicke, lawyer, Fort Worth, and Walter L. Summers, University of Illinois. The authors were described as two of the best-known United States authorities on oil and gas law in Walker's briefing of the work.

A lively discussion on flowing operations versus pumping operations in water flooding was provoked by a paper presented by D. B. Taliaferro, U. S. Bureau of Mines, Bartlesville, reviewing several Mid-Continent secondary-recovery projects. One authority present predicted considerable future use of flowing wells so as to reduce lifting costs. Taliaferro, in his paper, described a method of flowing wells on air or gas-repressuring projects "that appears to offer the advantages of flowing water-flood production without the disadvantages." This method is being used successfully in more than 200 Pennsylvania wells, but as yet has not been applied in the Mid-Continent.

In the final secondary-recovery discussion, N. E. Maxwell, Cities Service Oil Co., discussed using slides, the production histories of 13 water-flooding projects in Greenwood County, Kansas. The curve characteristics and the effect of various operating practices on production were covered.

The group session on production practices covered varied subjects ranging from mobile radio telephone service to an apprentice engineer training program. Harold S. Kelly, Phillips Petroleum Co., Bartlesville, described the 52-week planned training program inaugurated by his company 2½ years ago to replace the "pick and shovel" route required in past years. Kelly claims two ad-

(Continued on page 309)

KANSAS OIL AND GAS INDUSTRY AT A GLANCE

KANSAS—host state for the spring meeting of the Mid-Continent Division of the A.P.I.'s Production Division—is interesting to oil men for a number of reasons. It is the fifth largest producer of oil and gas in the United States. Eastern Kansas is one of the largest secondary recovery areas, with over 10,000 acres now under water flood producing in excess of 10,000 bbl. of oil daily. Hugoton gas field—the largest part of which lies in the state—has gas reserves estimated at 25 trillion cubic feet and is the world's largest gas field. At Garden City, a major oil company is starting construction on a multimillion-dollar hydrocarbon synthesis plant which will produce oil, motor fuels, and chemical byproducts from Hugoton gas. At Ellinwood, nitrogen is being used experimentally as a gas repressuring agent in pioneering secondary recovery work.

Here, in tabular form, are some of the statistical high spots in the Jayhawk state's oil and gas picture as compiled by The Oil and Gas Journal statistical bureau.

25 LEADING OIL PRODUCERS
(Daily Average Pipe Line Runs—1947)

1. Cities Service	34,280
2. Continental	17,640
3. Shell	13,590
4. Stanolind	13,340
5. Phillips	11,950
6. Gulf	10,130
7. Sunray	8,975
8. Skelly	8,960
9. National Cooperative	8,350
10. Sohio	8,000
11. Sinclair Prairie	7,420
12. Magnolia	6,340
13. Texas	6,190
14. Cooperative Refinery Assn.	4,530
15. Carter	4,050
16. Atlantic	3,600
17. Champlin	3,525
18. Lario	3,450
19. Deep Rock	3,090
20. Derby Oil	2,770
21. Bridgeport	2,370
22. Ohio	2,225
23. Vickers	2,120
24. Bay	1,980
25. Mid-Continent	1,550

NATURAL GASOLINE PLANTS

Company, field or plant, and county—	Approx. cap. (gal. per day)
Barnsdall Oil Co., Rainbow Bend, Cowley	*5,000
Cities Service Oil Co.:	
Main Line, Sedgwick	*104,000
Main Line, Cowley	*30,000
Burrton, Reno	*30,000
Continental Oil Co., No. 9 Cowley	25,000
Edwards Gasoline Co., Zenith, Stafford	2,000
Flynn Oil Co., Otis, Rush	*8,000
Kansas P. & L. Co.:	
Medicine Lodge, Barber	15,000
McPherson, McPherson	15,000
Northern Natural Gas Co., Hugoton, Seward	*71,700
Panhandle Eastern P. L. Co., Hugoton, Seward	55,000
Skelly Oil Co., Cunningham, Kingman	*50,000
Texas Co., The, Bearden, Cowley	*8,400
Total	419,100

*L.P.G. produced.

REFINERIES
(Kansas refineries are given on page 228 of this issue of the Journal.)

PRODUCTION AND RESERVE DATA

1947 crude-oil production, bbl.	104,000,000
Value of 1947 crude production	$200,000,000
1947 natural-gas production, billion cubic feet	180
Value of 1947 gas production	$10,000,000
1947 L.P.G. and natural gasoline production, bbl.	2,400,000
Value of 1947 L.P.G. and natural gasoline	$6,000,000
Cumulative oil production—Feb. 1, 1948, bbl.	1,779,186,832
Number of producing oil wells	27,867
Daily average production per well—1947	10.3
Proven crude-oil reserves—Jan. 1, 1948, bbl.	632,000,000
Proven natural-gas reserves—Jan. 1, 1948, billion cubic feet	14,100

10 PRINCIPAL OIL FIELDS

	Dly. avg. prod., Jan. 1948	Cum. prod., Feb. 1, 1948	Wells
Trapp	29,807	96,184,337	1,232
Kraft-Prusa	18,740	31,832,055	542
Bemis-Shuttes	16,077	49,554,765	507
Silica	13,068	77,706,562	710
Burnett	9,546	28,279,567	238
Hall-Gurney	8,722	34,190,098	660
Bloomer	8,232	27,626,978	273
El Dorado	7,461	195,826,730	1,672
Geneseo	7,149	22,064,113	188
Stoltenberg	6,550	25,255,477	325

DRILLING AND EXPLORATION DATA

Active rotary rigs*—Feb. 29, 1948	110
Geophysical crews in field*—Jan. 31, 1948	5
Core drill crews in field*—Jan. 31, 1948	5
Drilling depth record (Stanolind 1 Feather—1947), ft.	8,100
Producing depth record (Olson 3 Morrison—1936), ft.	6,481

*Interstate Oil Compact Commission figures.

WELL COMPLETIONS

	Total 1947	Feb. 1947
Total	2,694	191
Oil	1,303	97
Gas	452	23
Dry	912	70
Service	27	1
Average footage	3,226	3,215

International

WORLD-WIDE OIL DEVELOPMENTS

Bermudez Outlines Pemex Plans For Expanding Refining Industry

DETERMINATION of Petroleos Mexicanos to expand its refining capacity to meet the growing needs of Mexico for petroleum products was declared by Senator Antonio Bermudez, general manager, in a report March 18 marking the tenth anniversary of the date on which the Mexican Government took over the oil industry of the country.

After reviewing the progress and accomplishments of Pemex during the past decade and expressing confidence in the company's ability to meet problems of the future, Bermudez listed the projects scheduled for early construction.

To take complete advantage of the Poza Rica crude delivered to the "18 de Octubre" refinery, plans call for the construction of a plant to manufacture lubricants and paraffin from the residues of Poza Rica crude. This plant, estimated to cost 75,000,000 Mexican pesos, will be designed to produce 1,500 bbl. of high-quality lubricants and 65 tons of paraffin daily. These quantities will be sufficient to supply the domestic market and eliminate dependence on imports.

Pipe Line Planned

The volume of products now consumed on the Pacific Coast warrant construction of a 260-km. (160-mile) pipe line across the Isthmus of Tehuantepec, the report stated. This project will be completed by stages. Once the line is completed the products, such as gasoline, kerosine, gas oil, and diesel oil, can be piped to Minatitlan for processing, and from there to Salina Cruz for distribution by marine vessels. The same line will be used to transport crude, which will be refined at a new plant to be built on the Pacific side.

The site for this refinery will be at the port of Guaymas, and from there convenient distribution will be provided to all other consuming centers. The estimated cost of these projects is 18,000,000 pesos for the pipe line and 45,000,000 pesos for the refinery.

The concentrated demand of products around the Monterrey zone makes it necessary to establish a refinery there, Bermudez said. He declared that there is no doubt that in the future Pemex will have fields in the northwestern part of the country closer to Monterrey than present production, but a refinery center at Monterrey is justified even if the crude must be supplied from Tampico. He estimated the cost of this project at 100,000,000 pesos.

New Refinery Needed

The demand for products in the Guadalajara region cannot be supplied efficiently or economically by the present or planned refineries, the report stated, and the best solution is to build a refinery in that region with a capacity of 10,000 bbl. per day. This will be served by a pipe line of 248 kilometers from Salamanca to Guadalajara. The cost of this project is estimated at 46,000,000 pesos.

To meet the problem of supplying high-octane gasoline for the coastal region and to supplement the future producing capacity of the country, Pemex is contemplating the construction of a cracking plant at Tampico to cost some 25,000,000 pesos.

The report declared that Pemex is able to meet these expenditures with its own money and with the assistance of loans which have been applied for, and that all these projects will pay for themselves rapidly.

At present 27 wildcat wells are being drilled for Pemex by private contractors and plans for 1948 contemplate drilling only 53 wildcats because of the difficulties of securing equipment and supplies, the report declared, but the number of wildcats will be increased to the limit of the company's financial capacity as rapidly as additional equipment becomes available. Pemex plans to have 39 geological and geophysical crews in the field during 1948, of which 32 were reported to be at work at present. It was added that 150 locations have been established which have favorable probabilities for the discovery of oil or gas.

Two French Petroleum Companies Are Merged

Pechelbronn Quest, the only French oil company with any indigenous production (approximately 1,000 bbl. daily) and Les Propetrol Consommateurs de Petrol have merged their operations. The name of the new company is Societe des Raffineries Francaises de Petrole.

Les Propetrol Consommateurs has a 3,500 bbl. daily topping plant at Donges, near Saint Nazaire on the River Loire and supplies cylinder and axle oils to the French railways which own a percentage of this company.

Fort Worth Men Buy Into Mexican Company

An interest in New England Fuel & Oil Co. of Maine, a small crude producing company in Mexico, has been purchased by Neville G. Penrose, J. M. Zachary, and Hugh B. Smith of Fort Worth for $200,000.

The interest was purchased from Pablo H. Bush Romero, Mexico City, president of the firm. Penrose and Zachary have been made vice presidents, and Zachary will also serve as secretary-treasurer of the company.

New England owns nine wells producing about 200,000 bbl. annually, all of which is sold to Petroleos Mexicanos. It is planned to recondition the wells and increase production. The company has been producing crude in Mexico since 1912 and is one of the few foreign concerns not expropriated by the Mexican Government in 1938. Bush bought the company from Magnolia Petroleum Co. about 3 years ago. The deal of Penrose and associates is believed to be the first important American investment in the Mexican oil industry since the expropriation.

Socony-Vacuum Sees Early End To Red Line Agreement Dispute

International
WORLD-WIDE OIL DEVELOPMENTS

THE first official announcement concerning the probable settlement of the international dispute over the "Red Line Agreement"—which is holding up consummation of Arabian American Oil Co.'s expanded partnership—came from B. Brewster Jennings, president of Socony-Vacuum Oil Co., Inc., in his company's annual report, released late last week.

Jennings told stockholders that "if our continuing endeavors to adjust differences are unsuccessful, it is expected that the British courts will decide the issue sometime during 1948." Jennings also explained that "the complications surrounding acquisition by Socony-Vacuum of a 10 per cent interest in Aramco and in the Trans-Arabian pipe line now under consideration have not been resolved." Standard Oil Co. (N.J.) will become a 30 per cent partner in Aramco when the legal barriers are settled.

Liberal Terms Sought

From other sources it is understood that C. S. Gulbenkian, the 5 per cent partner in Iraq Petroleum Co., Ltd., who has objected to the Socony-Vacuum and Jersey Standard Aramco deal, is still holding out for more liberal terms. As previously stated *(The Oil and Gas Journal, October 11, 1947, page 48)* Gulbenkian is reported to be insisting upon the right to call for an increase in I.P.C.'s crude-oil production, at his discretion, and to be able to sell his increased share to the other I.P.C. partners if he cannot get what he considers a high enough price on the open market. To this and some other Gulbenkian demands, Socony-Vacuum and Jersey Standard will not agree.

If the question of the legality of the Red Line Agreement comes before the British courts, indications are that the courts will uphold the contention that because of the enemy alien status of one of the I.P.C. partners, Cie. Francaise des Petroles, the I.P.C. contract (including the Red Line Agreement) is null and void. But there appears to be some assurance that the matter will not be decided by a court, but rather that the companies and Gulbenkian will arrive at an amicable out-of-court decision.

The importance of Middle East oil was again emphasized by Jennings in the Socony-Vacuum report where he said:

"Successful completion of our Middle East plans should increase our supply of crude at eastern Mediterranean terminals from the present average of 10,000 bbl. daily (from Iraq) to approximately 150,000 bbl. daily. All of these projects have progressed with the utmost speed consistent with steel supplies and other factors. Because of the uncertain political conditions in the Middle East, however, some of these activities have been, and others may be deferred."

Crude Deal Settled

Aside from the Trans-Arabian pipe line, which is now under construction, Jennings had reference to the projected 34-36-in. pipe line from Iran and Kuwait. Jennings stated that negotiations have been completed with Anglo-Iranian Oil Co., Ltd., for the purchase of large quantities of crude oil from Iran and Kuwait over a 10 to 20-year period, the arrangement being contingent upon completion of the 34-36-in. line.

Meanwhile, Socony-Vacuum shortly will be lifting approximately 15,000 bbl. of crude oil from Iran and Kuwait on what is said to be a straight purchase arrangement. This crude oil is being shipped to the United States East Coast. Both the Iran and Kuwait purchases will be from Anglo-Iranian. The latter owns half of the Kuwait production.

On completion of the Kirkuk-Haifa segment of the 16-in. crude-oil line, which will parallel the existing 12-in. line, Socony-Vacuum's share will be stepped up to 20,000 bbl. daily, compared with 10,000 bbl. daily as at present, Jennings explained.

A.I.O.C. Manager Given Redwood Metal

H. S. GIBSON, general fields manager of Anglo-Iranian Oil Co., Ltd., was awarded the Redwood Medal for outstanding work in the production of petroleum by the British Institute of Petroleum at its March meeting in London.

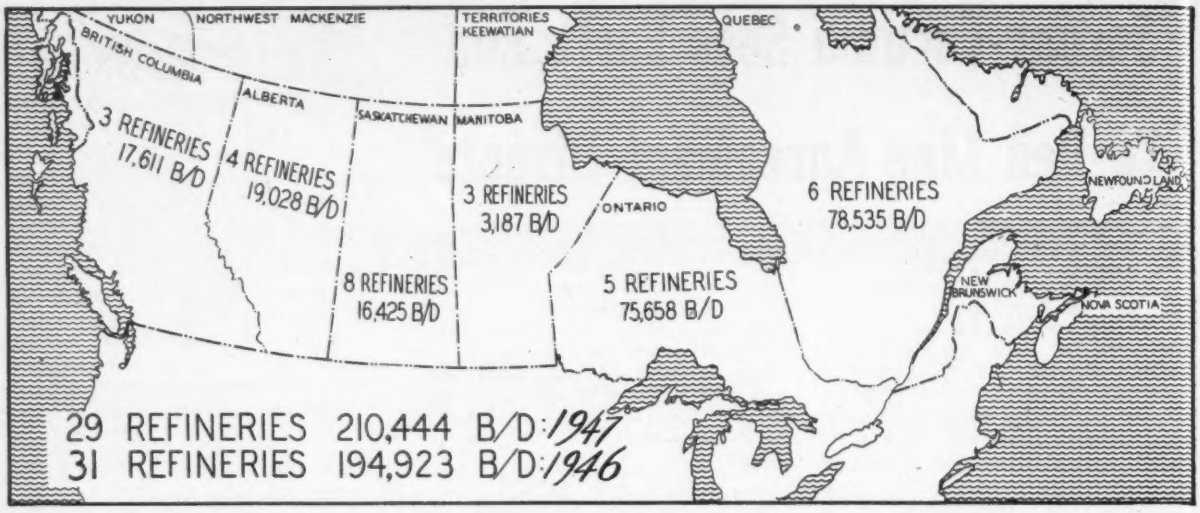
Presentation of the medal was made by the Institute's president, Sir Andrew Agnew, director of Shell Petroleum Co., Ltd., following Gibson's delivery of a paper on "Production of Oil from the Fields of Southwestern Iran," which summarized the methods employed and the results achieved in the company's operations in that area for more than 25 years.

Gibson was graduated in 1921 from Cambridge with a degree in mechanical engineering science; went to Iran in 1922, and has spent his entire professional life in that area.

The Redwood Medal is awarded "as and when desirable but not oftener than once a year to a petroleum technologist of outstanding eminence, irrespective of nationality, or of membership in the Institute." It was established in 1921 in honor of the founder-president of the Institute, Sir Boverton Redwood. Eight awards of the medal have been made, as follows:

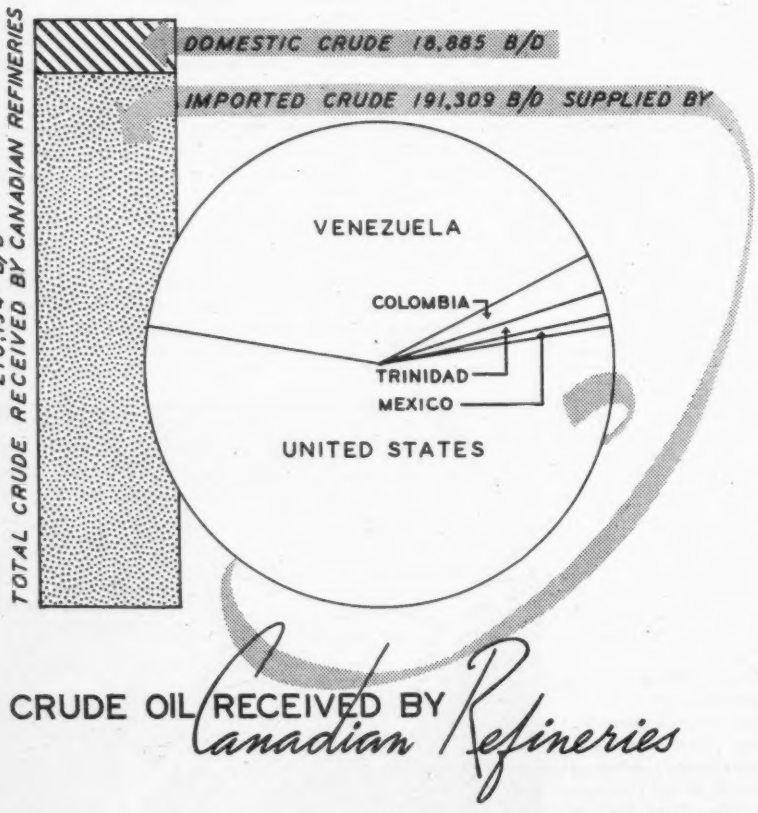
1921, Paul de Chambrier; 1925, C. H. McCarthy-Jones; 1929, W. H. Fordham; 1932, Dr. L. Edeleanu (Romania); 1934, Dr. David White; 1936, Dr. Harry Ricardo, F. R. S.; 1938, Dr. A. E. Dunstan; and 1947, H. S. Gibson, C. B. E.

H. S. Gibson (right), general fields manager, Anglo-Iranian Oil Co., Ltd., being presented the Redwood Medal of the Institute of Petroleum by Sir Andrew Agnew, president of the Institute



Map of the southern provinces of Canada showing the number of refineries (excluding small field topping plants) operating in each and the amount of crude processed during 1947. Figures for Quebec include the Maritime Provinces

Higher Canadian Refinery Operations Require More Imported Crude



Dependence of Canada on imported crude and the relative importance of foreign supply sources are shown in this combined chart based on official Dominion statistics

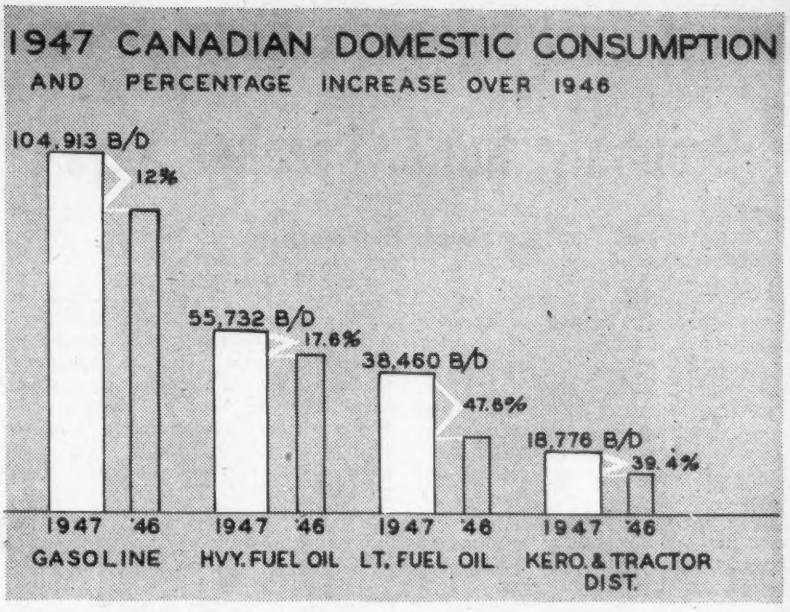
International

OIL refineries in Canada increased their operations by 8 per cent last year compared with 1946, expanding their imports of crude by 10 per cent, but consumption of major products in the dominion increased 20 per cent and imports of finished products rose 24 per cent during the year.

These figures are disclosed in the year-end report on refined petroleum products published by the Dominion Bureau of Statistics and converted here to a barrel-per-day basis to permit comparisons.

The most striking feature of the Canadian statistics is the increase in demand for light fuel oil during 1947; refinery production was up nearly 40 per cent, and consumption was reported as 47 per cent higher than 1946. At the same time consumption of kerosine and stove oil increased 51 per cent and heavy fuel oil 17 per cent.

Crude run to stills by all Canadian refineries totaled 210,444 bbl. per day in 1947, which was 15,521 bbl. per day more than the 1946 average. As shown in Table 1, this resulted in the production of 200,210 bbl. per day of finished products, an increase of 9.5 per cent over 1946, with the output



of all products except tractor distillate higher by widely varying percentages.

To meet this schedule Canadian refineries imported an average of 191,309 bbl. per day of crude, an increase of 10.4 per cent over 1946 imports. As shown in Table 2 and the accompanying chart, the bulk of this crude came from the United States. Imports from Colombia fell off more than half but there were large increases in receipts of Trinidad and Venezuelan crude and some was obtained from Mexico which did not ship to Canada the previous year.

Imports from the United States, the closest source of crude, did not increase last year as much as Colombian shipments decreased, and it is apparent that Venezuela is becoming an increasingly important source of crude for Canadian refineries.

Large increases in crude production from the newly discovered Alberta fields and from other Canadian fields failed to make up for the decline in output from Turner Valley, so that total Canadian production of 18,885 bbl. daily was 1.4 per cent below the 1946 output, as shown in Table 3.

Data on Canadian consumption and imports of principal petroleum products are given in Tables 4 and 5, though the two are not completely reconcilable. This is due, as explained in the official report, to the fact that figures on consumption given in Table 4 are compiled from statistics of imports, exports, inventories, and shipments of refiners and wholesalers only and do not take into account the amounts imported directly by industrial and other users. Table 5 is based on customs invoices and includes imports by both users and dealers, but does not take account of time lags in reporting nor of differences in classification and description of products.

TABLE 1—CANADIAN REFINERY OPERATIONS, 1947-1946

	Barrels daily			Per cent
	1947	1946	Change	change
Total crude runs	210,444	194,923	+15,521	+ 8.0
Total products consumed at refineries	221,238	202,671	+18,567	+ 9.2
Total production of finished products*	200,210	182,883	+17,327	+ 9.5
Naphtha specialties	2,259	1,997	+ 262	+13.1
Aviation gasoline	1,087	686	+ 401	+58.4
Motor gasoline	88,081	85,951	+ 2,130	+ 2.5
Tractor distillate	3,348	3,421	— 73	— 2.1
Kerosine and stove oil	8,285	8,066	+ 219	+ 2.7
Light fuel oil	35,144	25,151	+ 9,993	+39.7
Heavy fuel oil	44,189	42,992	+ 1,197	+ 2.8
Other products	17,817	14,619	+ 3,198	+21.9

*Does not include refinery fuel and losses.

TABLE 2—CRUDE OIL RECEIVED BY REFINERIES

	Barrels daily			Per cent
	1947	1946	Change	change
Total crude received	210,194	192,370	+17,824	+ 9.3
Domestic crude	18,885	19,153	— 268	— 1.4
Imported crude	191,309	173,217	+18,092	+10.4
United States	106,600	101,426	+ 5,174	+ 5.1
Colombia	4,955	11,585	— 6,630	—57.2
Venezuela	76,156	59,727	+16,429	+27.5
Trinidad	2,982	479	+ 2,503	+522.5
Mexico	616	.....	+ 616	.....

TABLE 3—DOMESTIC CRUDE PRODUCTION

	Barrels daily			Per cent
	1947	1946	Change	change
Turner Valley	14,419	16,755	—2,336	—13.9
Other Alberta fields	3,850	2,049	+1,801	+87.9
Other fields	616	349	+ 267	+76.5
Total	18,885	19,153	— 268	— 1.4

TABLE 4—CANADIAN DOMESTIC CONSUMPTION* MAJOR PRODUCTS

	Barrels daily			Per cent
	1947	1946	Change	change
Naphthas	2,481	2,319	+ 162	+ 7.0
Aviation gasoline	1,939	1,442	+ 497	+34.5
Motor gasoline	100,493	89,943	+10,550	+11.7
Tractor distillate	3,671	3,507	+ 164	+ 4.7
Kerosine and stove oil	15,105	9,964	+ 5,141	+51.6
Light fuel oil	38,460	26,063	+12,397	+47.6
Heavy fuel oil	55,732	47,382	+ 8,350	+17.6
Total major products	217,881	180,620	+37,261	+20.6

*The figures on domestic consumption are compiled by the Dominion Bureau of Statistics from reports received from refiners and wholesalers only, and do not take into account the amounts imported direct by industrial and other users.

TABLE 5—IMPORTS INTO CANADA OF PETROLEUM PRODUCTS
(According to the Official Trade Statistics)

	Barrels daily			Per cent
	1947	1946	Change	change
Oil from concentration of ores and metals	10	8	+ 2	+ 25.0
Crude petroleum for refining	187,498	173,696	+13,802	+ 7.9
Petroleum tops and blends	1,726	.....	+ 1,726	.....
Other crude petroleum	28	23	+ 5	+ 21.7
Fuel oil ex-warehoused for ships	875	1,011	— 136	— 13.5
Coal oil and kerosine	11,540	2,783	+ 8,757	+314.7
Engine distillate	182	170	+ 12	+ 7.1
Natural casing-head gasoline	4,359	4,535	— 176	— 3.9
Gasoline	13,573	9,294	+ 4,279	+ 46.0
Lubricating oils—less 25c gal.	432	357	+ 75	+ 21.0
Lubricating oils—over 25c gal.	637	497	+ 140	+ 28.2
Mineral oils, N.O.P.	60	55	+ 5	+ 9.1
Petroleum products, N.O.P. (40.3° A.P.I. or heavier)	29,255	8,575	+20,680	+341.2
Petroleum greases	87	78	+ 9	+ 11.5
Petroleum products, N.O.P. (lighter than 40.3° A.P.I.)	910	1,360	— 450	— 33.1
Total imports	251,172	202,442	+48,730	+ 24.1

Direct Fuel Injection Adds Power, Economy, S.A.E. Speaker Says

by Arch L. Foster

PHILADELPHIA.—It seems logical to assume that the ultimate power plant will be a two-cycle, high compression multifuel, direct injection engine, G. M. Lange and C. W. Van Overbeke, of Ex-Cell-O Corp., told the national transportation meeting of the Society of Automotive Engineers assembled here March 30-April 1.

New engine designs for the future will undoubtedly have higher compression ratios for greater power output. Equal distribution of fuel to all cylinders, attainable practically by direct injection, will be increasingly important to reduce detonation in these stepped-up engines, these authors said.

Successful application of fuel injection systems to spark ignition engines was made first by the German aircraft industry, beginning in 1934, and much of the efficiency of the German Luftwaffe engines is traceable to this advantage, the authors said. A fuel saving of 10 to 15 per cent was obtained by the use of injection systems, German documents show.

Economy Cited

Among the many advantages and efficiencies reported by these authors for fuel injection over the conventional carburetor systems is greater fuel economy, fostered by more even distribution of fuel to each cylinder which permits leaner fuel-air ratios without affecting adversely the engine's performance. Fuel consumption during acceleration and deceleration periods is improved greatly, since during acceleration it is not necessary to "load" the manifold to get the increases in power and speed, and when decelerating, the fuel supply can be shut off completely.

Engine power is augmented by direct fuel injection by increasing the volumetric efficiency, avoiding necessity for maintaining minimum air velocities. With a proper intake manifold design the pressure drop through the fuel system should not exceed ½-in. of mercury, they said. Fuel injection permits better cylinder scavenging and greater valve overlap without affecting fuel economy. It also avoids necessity for heating intake air to vaporize fuel and get it into the system, thus increasing the volumetric efficiency and permitting higher compression ratios for the same type of fuel.

Three basic designs of fuel injection systems have been developed which are considered satisfactory for automotive spark-ignition engines. These are multiple-plunger spill metering type; multiple-plunger variable stroke type, and the single-plunger injection pump which is divided into two variations, the distributor type and the intake metering type. Cummins Engine Co. and International Harvester have been leaders in developing this distributor unit, single-plunger type.

The single-plunger intake metering system has been applied to the pump developed by the Ex-Cell-O Corp. for use in automotive spark-ignition engines. In this type the fuel is sent by the supply pump to the metering valve, from which the amount of fuel delivered is controlled by supply reservoir pressure and throttle position. The pump throttle is linked to the air throttle in the proper ratio for the air required for any given amount of fuel supplied at any position. The supply pump sends up twice as much fuel as is required by the meter and the excess is returned via bypass to the tank.

Socony-Vacuum Begins Work at Staten Island

A $100,000 construction and repair program to modernize Port Socony on Staten Island, New York, is scheduled to begin immediately and to be completed sometime this year.

Socony-Vacuum Oil Co., Inc., has ordered seven of the new large-type tankers which are now under construction. The new modernization program will enable faster turnarounds at the port and also accommodation of the new large tankers.

Koppers Co. Is Awarded Synthesis Plant Contract

Koppers Co., Inc., Pittsburgh, this week was awarded a $4,413,250 contract by the Bureau of Mines for the design and construction of a gas-synthesis plant near Louisiana, Mo., to produce oil from coal.

This is the third and last of the demonstration plants planned under the synthetic-fuels research and development program of the bureau. Funds were authorized by the O'Mahoney-Case bill signed March 15 by President Truman.

Interior Secretary J. A. Krug said construction will begin within 3 months and completion is expected within 18 months. The plant, to be erected adjacent to the bureau's hydrogenation demonstration plant now under construction, will have a capacity of 80 bbl. of products daily.

Although using different processes, both of these plants will process coal. An oil-shale demonstration plant already is in operation near Rifle, Colo.

JOHN HOWARD TINKHAM

JOHN HOWARD TINKHAM, 48, in charge of the West Coast advertising office of The Oil and Gas Journal since 1932, died March 26 following an operation the previous day. He had a wide circle of friends throughout the West Coast oil industry and was closely associated with the activities of manufacturers and suppliers of oil-field equipment.

Tinkham was born in Logansport, Ind., and moved to Los Angeles in

1912. He graduated with honors in 1922 from University of California at Berkeley, receiving the degree of bachelor of science in mining engineering and a master's degree from the same university the following year. Later as a part-time student he studied law and graduated from the law school of University of Southern California in 1941.

His organization activities included membership in Sigma Xi and the Nomads. He was vice president in Los Angeles of the National Industrial Advertisers Association at the time of his death. He is survived by his widow and daughter, Pat. The family home is in Beverly Hills, Calif.

WASHINGTON WATCHING

BY BERTRAM F. LINZ

Steel for Stalin

WASHINGTON.—Congressional investigation of exports to Russia and its satellites is expected soon to touch upon petroleum equipment, for which large orders reportedly have been placed in this country.

A recent press dispatch from Romania disclosed that large quantities of needed supplies are being secured from the United States, and it is understood that orders for something in the neighborhood of $12,000,000 worth of oil-field equipment have been placed here and are now being filled.

These orders are said to have been secured toward the end of last year, and shipments began to move before the Commerce Department imposed a requirement that, effective March 1, individual licenses would be required for all shipments of all commodities to Europe.

Between $1,000,000 and $1,500,000 worth of equipment is reported to have been shipped already, with more free to be exported as having been in transit March 1, when the license regulation went into effect. It is assumed that licenses will be sought for future shipments under the "hardship" provisions of the regulations.

None of the equipment involved in the Romanian purchases consists of products on the positive list.

Latest Commerce Department figures show that total commercial exports from the United States to Russia last year had a value of $98,938,000.

Shipments included $3,500,000 worth of petroleum and products and $17,800,000 of mining, well, and pumping machinery. In 1938, our exports of petroleum and products were valued at $3,100,000 and of mining, well, and pumping machinery at $900,000.

In addition to the commercial exports, however, Russia last year received $16,300,000 of lend-lease, $32,100,000 of UNNRA, and $2,200,000 of private relief shipments, making her total receipts from this country $149,500,000, representing 1 per cent of all exports from this country. Our imports from Russia amounted to $77,102,000, mostly furs and metals.

Steel for Us

THE oil industry so far appears to be the only major steel consumer pressing for a definite allocation, and its position is represented as irking the steel producers who got much satisfaction out of the lack of interest by the freight car industry and farm implement manufacturers in the "divvy-up" plan.

The steel men admit that the oil industry will probably hold out for allocations on the ground it needs more steel and has been unable to get its share, and its attitude and what it finally gets from the allocation committee is seen as setting off the fireworks.

If oil and natural gas get anywhere near what they demand, the air will be filled with the demands of other users for their share of the available steel — for automobiles, freight cars, cans, agricultural implements, ships and even juke boxes.

Coming at a time when the steel producers don't know where their next carload of coal is coming from or when, the prospect of a battle royal over the allocation of steel that may not be produced isn't too palatable to them.

There were definite indications, too, that the Commerce Department plans to keep the volume of steel allocations within the industry's capacity to produce and at a level which will avoid serious dislocations among non-allocation steel users.

"Obviously," said John C. Virden, director of the Office of Industry Co-operation, "allocations of excessive amounts of steel and pig iron to participating industries would create serious dislocations in other segments of the economy, thus defeating the very purpose of Public Law 395."

Special Treatment

IT took a lot of argument, but the Oil and Gas Division finally was successful in writing more into the regulations on the procedure for adoption of the oil industry's voluntary code than is being permitted by the Commerce Department in its rules for other industries.

Commerce and Justice officials weren't keen on permitting the oil industry to make recommendations as to what should be incorporated in the agreement or digress in other ways from the hard and fast rules which will enable the Commerce Department to keep the reins tight when the steel and other industries come in under Public Law 395 to discuss the equitable distribution of scarce commodities.

OGD officials, however, were firm in their argument that the oil industry doesn't operate in the same way as other industries and has peculiar problems that require a different approach.

Aside from the special treatment given the industry, the regulations follow the general pattern laid down in the law and correspond closely with the Commerce Department's rules. The advisory committee will be representative of all interests in the industry, with due regard for the smaller units and the various geographical areas. Meetings will be called by Interior, which also will prepare the agenda for discussion; open hearings will be held before Secretary of the Interior J. A. Krug approves the agreement and sends it to the attorney general for clearance.

This week's meeting of the industry advisory committee may not develop anything more than the basic elements of the agreement, and it will probably be close to May 15 before the perfected document goes to the Justice Department.

Bogota Oil Seep

THE inter-American trade and economic conference at Bogota, Colombia, opened this week with every indication that oil will be a matter for consideration despite pointed suggestions by some Latin American countries that they would prefer to have the subject ignored.

Acting on such suggestions, the State Department recently let it be known that petroleum had been dropped from the agenda of the conference, but military officials who accompanied the U. S. delegation to Bogota are said to be determined to bring it up.

Once the subject comes up, the U. S. delegation is expected to tell the Latin American countries flatly that they can no longer depend upon us for oil supplies, other than lubricants and other specialties, and must start in developing their own resources.

It will be pointed out that the United States itself is not, at the moment, self-sufficient in oil; that exports of crude and several products are under rigid controls which are not likely to be lifted in the near future, and that such shipments abroad as are permitted must be channeled to countries which have little or no oil of their own.

Military officials in Washington have for some time centered much of their attention upon the possibilities of greater Western Hemisphere oil production as a substitute, in the event of war, for Middle East oil which probably would be unobtainable. Greatest drawback is the exclusion of foreign capital in the economic development of most of the Latin American countries.

Krug Plan Seen as Challenge to Industry Synthetics Program

by A. L. Solliday

Producing hydrocarbons from sources other than crude oil is one of the most talked about subjects in the industry today, and Stanolind's hydrocarbon synthesis plant, now starting construction near Garden City, Kans., is a most closely watched development.

The author is executive vice president, Stanolind Oil & Gas Co., Tulsa, and the presentation here is part of his address, "Significance of Hydrocarbon Synthesis in Western Kansas," given at the spring meeting of the A.P.I. Mid-Continent production division at Wichita, March 24-26.

THE hydrocarbon synthesis plant to be built by Stanolind near Garden City, Kans., will produce approximately 5,000 bbl. of high grade motor gasoline, 2,000 bbl. of distillate fuel, 300 bbl. of heavy fuels, and 400,000 lb. of oxygenated chemicals daily. These materials will be synthesized from approximately 100 million cubic feet of gas which will be produced from about 325 wells in Hugoton gas field. The gathering system will consist of 400 miles of pipe and will connect gas from approximately 200,000 acres.

The natural gas after gathering will be processed in a natural-gasoline absorption plant to extract an estimated 2,000 bbl. of butane and propane daily. The feed to the synthesis gas generators will be essentially free of propane and heavier hydrocarbons.

The fluid catalyst technique, so successfully employed in the catalytic cracking units, has been important in our developments. The use of oxygen in the manufacture of the synthesis gas is also an important part of our development. Oxygen extracted from the atmosphere is introduced with natural gas into a combustion chamber which operates at a temperature of about 2,400° F. and 300 lb. pressure. The main volume of gas from the combustion chamber passes into the synthesis reactors containing a fluidized bed of iron catalyst (mill scale from Colorado). The reactors operate at a pressure above 250 lb., and a temperature over 500° F. After leaving the reactors, the products are refined by conventional methods to produce gasoline, gas-oil, fuel oil, and other products.

Oxygen Output High

The oxygen plant to be constructed in connection with this project will have a capacity of 53 million cubic feet or 2,100 tons per day and will be the largest ever built. Its output will equal the entire prewar production of oxygen in the United States. The air will be brought into the oxygen plant at its normal atmospheric temperature and cooled to —270° F., where both the nitrogen and oxygen of the air will be liquid. The nitrogen and oxygen are separated by fractionation.

The synthesis and chemical plants will require about 250 million gallons per day of water for cooling purposes, steam generation and other plant uses. This quantity of water is about equivalent to the daily consumption of a city of over a million people. In order to conserve water, however, Stanolind is installing expensive water purification and cooling facilities in order to reduce the intake water volume for the plant.

As part of this program, Stanolind will build the largest cooling tower in the world. This cooling tower will be larger even than that installed by the Government atomic-bomb plant at Oak Ridge, Tenn. With the planned facilities, we expect to reduce our water requirements to only about 10 million gallons per day, less than 5 per cent of the total water circulated. This water will be obtained from deep sands by drilling water wells near the plant.

The synthesis plant and chemical plants will require about 600 employes. This means a community of approximately 2,000 people will be directly associated with the Stanolind plant at Garden City. We estimate the annual payroll will be about 3 million dollars.

Chemical Output Important

Contracts have been made with U. S. Industrial Chemicals, Inc., for the sale of the basic water-soluble chemicals produced in the synthesis plant. We are continuing research work on the utilization of other and newer chemical products which will be made available in quantity for the first time by the process.

The chemical products which will be produced in large quantities, should open new horizons to the chemical industry. Whereas the hydrocarbons produced in this plant will represent only about one-tenth of 1 per cent of American needs for refined petroleum products, the chemicals produced will represent approximately 4.5 per cent of the total production of such chemicals.

The production of these chemicals at reasonable prices will encourage the finding of new uses. Basic chemicals that will be available at the beginning of operations will supply manufacturers of drugs, synthetic soaps, plastics, paints, synthetic rubbers, and countless other products.

It is entirely possible that the synthesis plant at Garden City may grow into an industry many times greater than that presently contemplated. For instance, it is quite possible that other products, such as fertilizer, may be manufactured from some of the byproduct gases produced in the synthesis plant.

Gas Supply Adequate

The gas supply for the Stanolind synthesis plant appears adequate for about 25 years. It is our hope that additional discoveries in western Kansas will be made and that the plant life will be extended by the utilization of other sources of gas. It is possible that the plant will ultimately utilize gas produced from lignite or coal as a raw material.

It may be of interest to you to know why Stanolind is proceeding with its synthetic gasoline plant in western Kansas at the present time. We have committed many millions of dollars to this project—the sum total of which we will not know completely for several months hence. I might say, however, that we have been afflicted with the well-known increase in construction cost common in all industries today so that our present ideas of the cost of the plant are several times larger than our original figures.

We have decided to proceed with construction, however, largely on the basis of two specific conditions:

1. The hydrocarbon synthesis process will produce a large variety of

chemicals essential to the chemical industry and which will find a ready market.

2. We believe it inescapable that the day will come when the United States will manufacture large volumes of liquid fuels from coal. In anticipation of this day, we are installing our Kansas plant to develop the synthesis process. This process, in our opinion, will be the future cornerstone of our oil supply.

Challenged by Government

The Government has been urged by some to enter into the production of synthetic fuels. The secretary of the interior has talked of using public funds to the extent of 9 billion dollars for a 2-million-barrel-per-day synthetic-fuel industry. We believe this investment is grossly underestimated. Such a program will cost 20 to 30 billions of dollars instead of 9 billion.

The proposed Wolverton bill proposes to foster the production of synthetic liquid fuels from coal and oil shale. This bill would provide funds for the three full-scale demonstration plants: (1) hydrogenation of coal, (2) synthesis of liquid hydrocarbons from gases produced from coal, and (3) shale oil from oil shale. The Government has asked under the terms of this bill to sponsor this program to the tune of 400 million dollars.

It is a basic concept that when Government moves into industry on a commercial basis, utilizing taxpayers' money, and competing on a tax-free basis with free enterprise, industry's incentive vanishes and progress ceases.

Our action in the synthetic program is just one instance of accomplishment by American industry. Stanolind's position today is rather ironical. After 10 years of arduous research and the dedication of much capital to this commercial plant, we find the Government is asking not for millions, but billions of taxpayers' money to plunge the Government into competition with us.

Stanolind received no government subsidy, nor any special favors from the Government in all of its development work. We were actuated by that same spirit of enterprise which has been responsible for placing our industry foremost in the world in meeting the public's requirements.

Research Favored

I am in agreement with basic intent of the proposed Wolverton bill in fostering and encouraging the development of synthetic liquid-fuel production from coal, oil shale, and other sources, but I am completely opposed to the Government directly or indirectly, entering this or any other activity in direct competition with private industry.

It is also my feeling that government funds would not be wisely spent in building commercial scale demonstration plants to prove the synthetic process when the two commercial plants now building are based upon engineering far ahead of that possessed by the Interior Department. At least three major oil companies are cooperating with the coal industry, or with other research organizations, in the development of a process for obtaining liquid fuels from coal. Based on the past performance of the refining industry, with its millions currently being spent on research, and with its thousands of engineers and scientists with a long background of practical training and experience, it is reasonable to predict that the objective of more liquid fuel will be attained by the petroleum industry.

There are fields in which the Government can contribute substantially to the over-all problem. The work now being done by the Government on gasification of coal, underground, by retorting, or by other means should be continued. Research on methods of mining oil shale, production of oil from shale and methods of refining the oil on a pilot plant basis could well be continued by the Government. Hydrogenation of coal appears to be definitely uneconomic but some more research and pilot plant work might be desirable. Faster progress can be assured by the erection and operation of small pilot plants, constructed so as to investigate numerous methods, rather than by the erection of large plants to prove operability which can adequately be demonstrated in small and relatively cheap pilot plants. Moreover, for the Government to enter into competition with the industry in fields where industry has already made striking progress would defeat the ultimate objective—to produce the greatest amount of synthetic fuels in the shortest possible time to augment our petroleum supply.

I should like to point out that crude oil is in general still the most economic source of liquid fuels. Currently the basic solution to our liquid-fuel problem is a healthy crude-oil industry. It will ultimately save billions of dollars in synthetics plant investment and operating costs. A healthy crude-oil industry will permit a gradual shift to synthetics and will insure that the plants constructed for this purpose have behind them the full technical skill and engineering know-how that only American free-enterprise system can assure.

Shell Opens Louisville Products Water Terminal

Shell Oil Co., Inc.'s first postwar water terminal for petroleum products at Louisville, Ky., was formally opened March 30. The terminal occupies 5 acres and has a storage capacity of 1,800,000 gal. River frontage is 875 ft. with a dock to accommodate two barges.

Tidelands Legislation Advanced in Congress

WASHINGTON.—A House judiciary subcommittee which sat in with a similar Senate group during the hearings on the tidelands legislation voted last week to send the measure restoring California's title to her offshore lands to the full committee with a recommendation for favorable action.

The Senate subcommittee approved the bill within 10 minutes after the hearings ended a week earlier.

A new bill, containing protective clauses to clarify the scope of authority under state ownership of tidelands, was introduced in the House by Rep. E. Wallace Chadwick of Pennsylvania, chairman of the subcommittee.

Chadwick's bill would declare as state property all lands beneath navigable waters at the time the state entered the Union between the line of mean high tide and the 3-mile limit or such boundary line seaward as the state may have had originally or as may have been approved by Congress. Any state which has not already done so may extend its seaward boundaries to the 3-mile limit.

The measure stipulates that nothing therein shall affect the use, development, improvement and control by the federal Government of tidelands and waters for purposes of navigation, flood control or production of power.

Governors Are Asked To Permit Maximum Output

WASHINGTON.—An appeal to the governors of the oil-producing states to assure that their fields are allowed to produce at maximum efficient rates has been sent out by Interior Secretary J. A. Krug at the request of President Truman, it was disclosed March 30 by Sen. Kenneth S. Wherry of Nebraska.

Wherry, chairman of a Senate small business oil subcommittee, released a letter received from the President in reply to his recommendation March 4 that the Connally Act be suspended as a means of forcing the conservation state to increase output.

In his letter, the President pointed out that the act does not restrict or curtail production and maintained that the only effect of its suspension would be "the possible encouragement of the production and interstate shipment of contraband oil."

Natural Gasoline Faces Record Demands, Greater Problems

by George Weber

FORT WORTH.—Unprecedented demands for natural gasoline and liquefied petroleum gases, with the attendant responsibilities facing their industry, were reviewed in detail by members of the Natural Gasoline Association of America, meeting for the twenty-seventh year, March 24-26.

A balanced program of technical presentations, economic reviews, and progress reports reflected the current importance of L.P.G. products whose phenomenal acceptance is inciting costly investment throughout the industry to increase recovery of propane and to add to L.P.G. storage facilities. The twenty-five-fold increase in L.P.G. production during the past decade was repeated in several general reports on industry progress, and two of the technical papers concerned methods for increasing L.P.G. recovery.

Contributions to the technology included a study of "Condensation of Hydrocarbon-Water Mixtures in Fin-Wall Tubes" by Dr. D. L. Katz and D. C. Gillespie, University of Michigan, and "Application of Superexpansibility Factors in High-Pressure Gas Measurement" by E. P. Valby, Richfield Oil Corp., Los Angeles.

In his annual report of progress in combating corrosion in high-pressure gas-condensate wells, T. S. Bacon, Lone Star Producing Co., Dallas, chairman of N.G.A.A.'s corrosion research project committee, revealed that joint studies of such corrosion have narrowed causes primarily to the presence in well effluents, of carbonic acid, and lower fatty acids in water solution. Of preventive measures, the committee reported the year's findings from laboratory and field testing of coatings, films, chemical additives and alloys. Some success has followed the use of coatings of thermo-setting resins on tubing and surface connections.

Chemical additives still show mixed success. Inorganic alkalines, although inexpensive, cause deposition and plugging when contacted with water production carrying calcium salt solutions. Field trials using sodium bicarbonate solutions are now under way in an effort to determine the effectiveness of that relatively cheap additive. Organic chemicals, as previously reported, show wider adaptation but at greater cost. Mechanical problems involving addition of chemicals to dual wells were reviewed and use of the solid chemical stick, dropped in the hole, was offered as a possible solution in some cases.

For the first time, material progress was reported on the application of ferrous alloys in corrosion prevention. Steels of 9 per cent chromium or 9 per cent nickel content have shown very superior resistance to corrosion in the laboratory and as coupons in field tests, and it is believed that a 5 per cent nickel alloy may prove satisfactory in practice. In January, an order was placed for 200,000 ft. of special alloy tubing, for use in corrosive wells, and field-testing of these strings will in time settle the question whether alloys, costing 3 to 5 times as much as ordinary tubing, will prove the economic solution to the extremely costly corrosion problem facing many gas-condensate producers.

Four papers presented at the annual N.G.A.A. meeting were published in the Natural-Gasoline Number of The Oil and Gas Journal, March 25. The papers and their authors were "Economics of Antidetonant Injector Through New Automatic Octane Booster for Engines," C. H. Van Hartesveldt, Thompson Vita-Meter Corp.; "Significance of Liquids from Natural Gas," C. R. Williams, Chicago Corp.; "A Study of Cycling Operations in the West Austin Sands of Stratton-Agua Dulce," Charles B. Johnson, Jr., Chicago Corp., and Dr. Frank H. Dotterweich, Texas A. & I. College; and "Modern Process Methods to Improve L.P.G. Recovery," G. W. McCullough, K. H. Hackmuth, and A. J. Miller, Phillips Petroleum Co.

Economics Discussed

Public opinien, federal control and balance of supply and demand figured in all economic discussions before the

Officers and directors of the Natural Gasoline Supply Men's Association, seated left to right: C. C. Clover, Westcott & Gries, Inc., director; V. C. Canter, Jones & Laughlin Supply Co., director; J. N. McClure, Elliott Co., first vice president; Roy R. Bush, Nordstrom Valve Co., new president; L. L. Dresser, Dresser Engineering Co., second vice president; Dallas S. Deem, American Air Filter Co., Inc., director; and William F. Lowe, secretary. Standing: R. T. Roberts, Goulds Pumps, Inc., director; Warner Lewis, Warner Lewis Co., director; M. E. Duncan, Johns-Manville Sales Corp., director; Walter D. Smith, Worthington Pump & Machinery Corp., director; John H. Heinzerling, Vinson Supply Co., past president; M. A. Ellsworth, Fluor Corp., Ltd., director; L. D. McKay, Union Steam Pump Sales Co., director; and H. M. Rosevear, Wyatt Metal and Boiler Works, director

Last year's N.G.A.A. officers were reelected for a second term: Left to right are Albert H. Weil, United Gas Pipe Line Co., Shreveport, vice president; R. D. Gibbs, Union Oil Co. of California, Los Angeles, vice president; C. R. Williams, Chicago Corp., Corpus Christi, president; James E. Pew, Sun Oil Co., Philadelphia, vice president; and William F. Lowe, Tulsa, secretary-treasurer. Not present was Henry M. Brown, Midland Gasoline Co., Houston, vice president

association. Speaking of the oil industry, R. M. Chan, vice president, Magnolia Petroleum Co., Dallas, surveyed war and postwar demand which for all oils showed for 1947 an increase of 33 per cent over 1941 while natural gas production rose 60 per cent for the same period.

He reminded the group of the attacks aimed at the oil industry recently, and discussed the "cure-all" proposals coming from various points outside the industry. Although petroleum has assumed an ever-increasing load as a domestic heat and energy source, he labeled as ill-advised and not in the public interest the proposal that prices be increased to discourage the use of petroleum in preference to other fuels. The answer lies, he stated, in an expanding supply and not in restriction of effort.

To the criticism of "so-called abnormal profits" in the industry, he continued, "all companies in the industry are faced with replacing depreciating and wasting assets at many times their cost. Real profits are not being realized to the extent indicated in present earnings statements, as depreciation and depletion reserves now being provided are based on low-cost assets, and are not sufficient to provide for their replacement at present prices. We must devote a larger and larger proportion of our earnings to capital investment simply to maintain the assets at the true value they had before inflation took over, to say nothing of the inflated cost of investing in assets necessary for expansion."

"As far as the short-range outlook is concerned, total supply this year should be adequate, with the possibility of spot dislocations in certain areas. A major requisite just now is to get enough tools to work with. We need materials—oil country goods; line pipe; drill pipe; casing; tubing; refining equipment." He concluded that he knew of no better plan for solving current and future problems than "to leave the problem where it has always rested—in the hands of the members of the industry itself."

Gas Conservation Reviewed

In a forthright discussion of the position of the industry and state regulatory bodies concerning conservation of gas and gas products, William J. Murray, Jr., Texas Railroad Commissioner, reported on the progress in Texas and the work yet to be done. He reported in detail on casinghead gas conservation projects in Texas: 45 plants utilizing 572 million cubic feet daily completed since 1945; 22 plants to process and utilize another 322 million cubic feet now under construction; and 30 other projects involving 183 million cubic feet daily now in the planning stage. He noted that even these strides toward ultimate conservation of all casinghead gas in the state had hardly kept pace with the increase in gas production which followed the rise of oil withdrawals to the present maximum efficient rate. As a result, despite the long-range plans for conserving all casinghead gas economically possible, recent unforeseen oil allowable increases have temporarily offset reduction of flare gas. Continued efforts along this line as materials and tools permit, he declared, is mandatory, with the result of failure not alone federal control but nationalization of the entire industry.

Richard Wagner, president, The Chicago Corp., in an address entitled "Risk Capital in the Petroleum Industry," stated that the sources of risk capital in this country are drying up. As distinguished from trust funds and capital held by banks, insurance companies and corporations, risk capital was described as privately held wealth invested in business ventures promising less assurance of safety but greater possible gains or returns. This type of capital, which he cited as having played an important part in the development of the petroleum industry, is being reduced by high income and inheritance taxes, public spending, restrictive laws, labor demands, and export of capital goods. Wagner declared as false the doctrine of a riskless society, and called for reversal of recent trends which have reduced investment of venture capital in American industry.

Motor-Fuels Session

Papers read in the motor-fuels session underscored the trend toward greater compression ratios in automotive engines which promise improved economy of higher octane fuels in the future. Referring to an increase of 30 per cent in average efficiency of fuel utilization in passenger-car engines since 1930, J. M. Campbell and L. L. Withrow of General Motors Corp.'s research laboratories division presented data on experimental high-compression engines which have been built and tested by that company. The paper described an engine with a 12½:1 compression ratio, which engine, mounted in a 1947 model Oldsmobile, was driven to Fort Worth for demonstration at the meeting. As compared with a 1946 production engine of comparable horsepower, the six-cylinder experimental engine showed: a displacement of 181 cu. in. vs. 238 cu. in.; compression ratio of 12.5:1 vs. 6.4:1; maximum brake horsepower of 95 at 3,600 r.p.m. vs. 85 at 3,400 r.p.m.; and miles per gallon at 40 m.p.h. of 26.5 vs. 18.5. The experimental engine uses gasoline having a Research octane number in the vicinity of 100 plus 0.2 ml. of tetraethyl lead and a Motor octane number between 88 and 90.

Preview of

NEXT ISSUE

WHAT are the possible costs and material requirements for producing synthetic fuels from natural gas?—coal?—and oil shale? The president of Standard Oil Development Co., one of the leading concerns in research in this field, has written a special article for the Journal which gives many informative data and figures on these questions.

Frederic H. Lahee, chief geologist for Sun Oil Co., annually prepares a notable review of exploratory drilling data and results. By special permission to the Journal from the author and the A.A.P.G., Lahee's latest figures are to appear, together with explanatory maps.

How much strain should be left in casing strings after cementing? This is discussed by the chief field engineer for Spang-Chalfant.

By Journal editors: Account of special plan followed in completing the Mid-Continent area's latest unitized oil-field operation—Design of a new "midget" gasoline plant for smaller leases and lower volume gas supplies—New $2,000,000 expansion in research laboratories by a Standard Oil Co.

PERSONALS

McCollough to Head Amerada Operations

EDWARD H. McCOLLOUGH, vice president in charge of Pacific Coast and Canadian operations for Amerada Petroleum Corp. since 1934, has been appointed vice president in charge of all operations of the company. McCollough will retain his previous responsibilities in addition to including those formerly handled by the late Allmand M. Blow, whom he succeeds.

McCollough joined the geological department of Amerada in 1925 following his graduation from the University of Oklahoma with a master's degree in geology. In 1928 he was sent to California to initiate company operations in that state, and in 1934 was made vice president in charge of operations on the Pacific Coast and in Canada.

A native of South Carolina, McCollough spent his early years in Houston. He is a member of the American Association of Petroleum Geologists and the American Petroleum Institute. He will make his headquarters in Tulsa.

M. M. Luther, formerly with Stanolind Oil Purchasing Co., has joined Husky Refining Co. as treasurer and office manager. The company has begun construction of a new office addition to its facilities in North Cody, Wyo. **Kenneth Lindsey,** formerly with The Texas Co. in Denver, has joined the company as petroleum engineer. **Rowland F. Cowley,** treasurer of the company, has been made superintendent in charge of production and **J. C. Gilbert,** former production superintendent, has been named to head the petroleum and economics department of Husky.

E. G. Youngberg, general manager for Pana Refining Co., Pana, Ill., has joined Allied Oil Co., Inc., Cleveland, Ohio. He will devote most of his time to the procurement of petroleum products for Allied and will supervise the company's new office which is to be established soon in the Chicago area.

R. J. Beams, geologist and petroleum engineer for Shell Oil Co., Inc., has resigned to become a consultant in Oklahoma City.

Frank Neighbor, district geologist at Ardmore, Okla., for Sinclair Prairie Oil Co., for the past 8 years, has resigned effective April 1 and will move to Salt Lake City, Utah.

R. P. Huggins, who organized the accounting department of Western Gulf Oil Corp. when the company was founded in 1928, has been elected vice president of the organization.

Claig H. Perry, formerly gas engineer in charge of exploration work for Warren Petroleum Corp., Tulsa, has resigned to join Texas Natural Gasoline Corp. as secretary and manager of the gas division. Texas Natural is a recently organized affiliate of Edwin B. Cox & Jake L. Hamon, Dallas. Perry joined the Warren organization when Warren acquired the natural gasoline department of Amerada Petroleum Corp. Perry at that time was chemist in charge of the laboratory for Amerada's Coleman, Tex., plant. He was made gas engineer for Warren in 1944.

D. N. Barrow, assistant superintendent, natural-gasoline division, Arkansas Fuel Oil Co., Shreveport, has been elected chairman of the Ark-La-Tex section of the American Chemical Society. Barrow succeeds **Guy S. Mitchell,** Lion Oil Co., El Dorado, Ark., who was elected to the national council of the society. **Harry J. Sheard,** Bayou State Oil Co., Shreveport, was named section chairman-elect; **J. O. Griffin,** Atlas Oil & Refining Co., Shreveport, is secretary-treasurer, and **Dr. John B. Entrikin,** head of the Centenary College chemistry department, was named director.

R. L. Denton, chief scout for Magnolia Pipe Line Co. at Midland, Tex., has been transferred to Magnolia Petroleum Co. in the crude-oil division.

D. D. IRWIN

L. F. McCollum, president of Continental Oil Co., and **David D. Irwin,** vice president in charge of transportation and supply of Pure Oil Co., have been elected to the board of directors of Great Lakes Pipe Line Co. to succeed **Dan Moran** and **C. B. Watson. A. L. Walker,** who has been in charge of traffic since the products pipe line company began operations, was elected vice president for traffic. **Harry Moreland,** president of Great Lakes, was reelected.

A. C. Sailstad, vice president, Stanolind Oil Purchasing Co., Tulsa, has been elected executive vice president. **Charles G. Irsch,** assistant administration coordinator, Stanolind Oil & Gas Co., has been transferred to the Stanolind Oil Purchasing Co. and elected director in charge of accounting and finance.

Stanton Smith, president of Smith Oil & Refining Co., and **G. Stewart Brown,** manager of the public-relations department for Standard Oil Co. of California, have been elected to the Oil Industry Information Committee.

W. C. MacMillan, vice president in charge of production and drilling operations for Continental Oil Co., Ponca City, Okla., has been elected president of Texon Oil & Land Co., Group No. 1 Oil Corp., and Group No. 2 Oil Corp., nonconsolidated affiliates of Continental. Texon operates in Oklahoma, Texas, and Kansas fields. **E. J. Sheldon,** Ponca City, has been named a director of Texon Oil & Land Co.

Dolphe E. Simic, division geologist in North Texas for Bay Petroleum Corp. and Chalmette Petroleum Corp., has been appointed chief geologist and exploration manager for those companies. He succeeds **E. L. Birmingham,** who has resigned to form a partnership with **William N. Bartlett** at Wichita, Kans. Simic was engineer for 6 years with Socony-Vacuum White Eagle division refinery at Augusta, Kans.; he was with Cities Service Oil Co. for 10 years as geologist in Oklahoma and Texas; and he served 4 years as district geologist for Cities Service in West and North Texas areas.

PERSONALS

A. F. Driskill, drilling superintendent of Iraq Petroleum Co., Ltd., is back in the United States for a 3 months' visit before returning to the Middle East.

T. M. Mannhart, vice president of Seismograph Service Corp., is in Venezuela inspecting company operations.

R. E. Ginna, vice president of Rochester Gas & Electric Corp., Rochester, N. Y., has been appointed chairman of the Committee of Economics of the American Gas Association. **Harry A. Weitzman,** manager, rate and economic research department, Rochester Gas & Electric Corp., has been appointed chairman of the subcommittee on statistics. **F. B. Jones,** manager, sales and market research, Equitable Gas Co., Pittsburgh, was named chairman of the subcommittee on marketing and sales problems. **E. W. Morehouse,** vice president, General Public Utilities Corp., New York, was appointed chairman of the subcommittee on economic problems.

A. W. BAUCUM

A. W. Baucum, assistant South Texas division manager for The Texas Co., Houston, has been appointed assistant to the manager of the producing department, **E. R. Filley,** effective April 1. Baucum joined The Texas Co. in 1934, after graduating from Texas A. & M. College in petroleum engineering. In 1944 he was appointed division petroleum engineer of the Oklahoma-Kansas division at Tulsa. He was named assistant South Texas division manager in 1946. **George H. Clark,** division geologist in the South Texas division, has been named acting assistant manager of the South Texas division, producing department. **S. A. Berthiaume** is being advanced from geologist to acting division geologist as a result of Clark's transfer. He was formerly district geologist at San Antonio prior to his transfer and promotion to senior geologist at Houston. **C. F. Redmond, Jr.,** petroleum engineer in the West Texas division, has been named manager, producing department, at Houston where he will work on the staff of **E. P. Hayes,** chief petroleum engineer.

J. L. Kincaid, assistant gas engineer at the Pure Oil Co.'s Van, Tex., gasoline plant, will be transferred to Pure's Texas Producing division headquarters in Fort Worth, April 15, as assistant production engineer. **Charles T. May,** assistant in the production engineering department, Fort Worth, will be transferred to Van, as assistant gas engineer in the gasoline plant.

Martin M. Sheets has resigned as division geophysical supervisor for Stanolind Oil & Gas Co. to become chief geologist for Production Maintenance Co., Houston. Sheets, who received his bachelor's and master's degrees from the University of Oregon and did further graduate work at the University of Cincinnati, spent 2 years in the petroleum engineering department of Humble Oil & Refining Co. before joining Stanolind as scout in 1935. He will be in charge of all exploratory work for Production Maintenance.

Tom Woods, formerly drilling supervisor of Socony-Vacuum Oil Co. of Colombia, has joined Standard-Vacuum Oil Co. and shortly will be transferred to Sumatra, N.E.I.

Richard W. Fry, formerly with Continental Oil Co. in Corpus Christi, Tex., and **George W. Strake** in Houston, have been made district land men for Warren Oil Corp. in Corpus Christi.

Peter Paul, formerly assistant superintendent of the British American Oil Co., Ltd.'s plant at Toronto, has joined the staff of Texaco Development Co. in New York, as assistant to **W. P. Gee,** Texaco Development vice president.

S. W. Floyd, manager of the foreign department of Phillips Petroleum Co., left Tulsa March 18 on his return trip to Caracas, Venezuela. Floyd spent 2 weeks in Bartlesville, Okla., where he conferred with Phillips executives.

H. D. Borne, assistant secretary and treasurer of Texas Pipe Line Co., has been elected secretary and treasurer for Texas-Empire Pipe Line Co. and Kaw Pipe Line Co., Tulsa. Borne succeeds the late B. A. McKerren. **L. J. Shelton,** Tulsa, has been named to succeed Borne as assistant secretary and assistant treasurer of Texas-Empire Pipe Line Co. Shelton also was promoted to assistant secretary and assistant treasurer of Kaw Pipe Line Co. **John W. Emison,** vice president and assistant general manager of Texas Pipe Line Co., Houston, and **T. P. Steeper,** vice president of Empire Pipeline Co., Bartlesville, Okla., have been elected members of the board of directors.

C. E. Finney, Jr., vice president in charge of industrial relations for Standard Oil Co. of California and general manager of Standard's manufacturing department, has been named president of the Salt Lake Refining Co. and Salt Lake Pipeline Co. Both are subsidiaries of Standard of California.

J. L. Jones, pipe line superintendent for United Gas Co., in the Shreveport district, has been made assistant district manager. He is succeeded by **J. M. Steele,** of the Monroe office. **H. C. Pegues,** of Jackson, Miss., has been named superintendent of dispatching in the Shreveport office. Other changes include: **D. M. Simmons,** promoted to assistant general superintendent of the general office production department; **E. E. Richards** to drilling and production superintendent; **C. A. Sullins** to drilling and production superintendent in Beeville, Tex., district; **J. P. McCullough** to contracts supervisor in the general office gas-supply department; and **J. G. Hill,** of Beeville, to Shreveport as field supervisor.

Giles E. Wimberly, formerly in the Fort Worth offices of the Gulf Oil Corp., has been named special assistant to **Walter B. Pyron,** Gulf vice president and representative in Great Britain.

Fred L. Whiteley, Whiteley Oil Co., Columbia, Mo., has been reelected president of the Missouri Petroleum Association.

N. P. Isenberger, director of foreign exploration for Phillips Petroleum Co., has been elected vice president in charge of geological and exploration activities abroad for American Independent Oil Co.

H. R. Riedell, formerly an executive assistant at San Tome, Venezuela, for Mene Grande Oil Co., has been made assistant manager of the company's western division at Maracaibo.

Guy Warren, Corpus Christi, Tex., has been elected president of the Texas Independent Producers and Royalty Owners Association. He succeeds **H. J. Porter,** Houston. **W. T. Beard, Jr.,** San Antonio, was elected treasurer, and **C. P. McGaha,** Wichita Falls, Tex., secretary. **E. I. Thompson,** Austin, was renamed executive vice president.

J. M. Fleming, chief field clerk for Pure Oil Co. at Pauls Valley, Okla., has been elected secretary-treasurer of the Golden Trend chapter of the American Petroleum Institute to replace **Paul B. Myers,** recently re-

PERSONALS

signed from Mid-Continent Supply Co., to become a partner in the Drilling Manufacturing Co., Oklahoma City.

V. A. Peterson, formerly at Casper, Wyo., and **John Keplinger,** a graduate of Southern Methodist University, have been assigned to the Wichita geological office of Atlantic Refining Co. **Harold Trager** is district geologist there.

H. E. Brandli, vice president and general manager of Cities Service Oil Co., has been elected president of the Oil Trades Association.

Charles A. Miller, personnel and safety director of The Texas Co., has been named president of the Texas Safety Association for 1948. **R. B. Roaper,** chief safety engineer, Humble Oil & Refining Co., was named vice president for schools and colleges; and **E. F. Schmidt,** vice president of Lone Star Gas Co., vice president in charge of membership.

Jack Harris, of California Co., has been transferred to Denver as assistant exploratory supervisor for the western division of the company.

Joseph L. Burke, executive vice president of Stanolind Pipe Line Co., Tulsa, is presently enrolled in the Advanced Management Training Program of the Harvard Graduate School of Business Administration.

Earl Sturm, lease foreman for Phillips Petroleum Co. in the Holliday area, North Central Texas district, has been made district superindendent, Illinois district.

Leon Martin, formerly superintendent of the Roosevelt Oil Co., Mount Pleasant, Mich., refinery, has joined Graco Oil Co. as general manager of that company's refinery at Newcastle, Wyo.

Lloyd E. Elkins, chief engineer, producing department, Stanolind Oil & Gas Co., has been elected chairman of the Mid-Continent district of the American Petroleum Institute for production. **John H. Field,** Sohio Petroleum Co., Oklahoma City, was elected vice chairman for Oklahoma; **Lloyd Pickrell,** Wichita, vice chairman for Kansas; **Dallas Bowsher,** Skelly Oil Co., Pampa, Tex., vice chairman for the Panhandle; and **Harold Berg,** Tide Water Associated Oil Co., Tulsa, was elected secretary-treasurer. **W. L. Horner,** Barnsdall Oil Co., Tulsa, was elected chairman of the district's 52-man advisory committee.

F. G. Cottle, manager of supply for Imperial Oil, Ltd., has been named technical adviser on petroleum products to the federal reconstruction and supply department at Ottawa. Cottle, who served as deputy administrator in the oil controller's office during the war, will represent the department in discussions at Washington.

George V. Holton, vice president, general counsel and a director of Socony-Vacuum Oil Co., Inc., has been elected a director of the Commerce and Industry Association of New York.

SHIFTS—

Joe J. McCullough, geologist, Union Oil Co. of California, Paso Robles to Orcutt, Calif.; **Joe A. Everitts,** superintendent, Ohio Oil Co., Bakersfield to San Francisco; **E. R. McGee,** engineer, Richfield Oil Corp., Tupman to Bakersfield, Calif.; **R. S. Crog,** chemist, Union Oil Co. of California, Wilmington to Los Angeles; **H. V. Copeland, Jr.,** geologist, Magnolia Petroleum Co., Aztec to Artesia, N. M.; **John D. Culp,** engineer, Stanolind Oil & Gas Co., Hobbs, N. M., to Tulsa.

R. N. Bills, geologist, Amerada Petroleum Corp., Robstown to Victoria, Tex.; **O. I. Jantz,** foreman, Amerada Petroleum Corp., Fayette, Miss., to Hazelhurst, La.; **L. Decker Dawson,** foreman, Republic Exploration Co., Hereford, Tex., to Guthrie, Okla.; **E. L. Mount,** foreman, Continental Oil Co., Ballinger to San Angelo, Tex.; **R. C. Eubank,** superintendent, Sun Oil Co., Beeville to Victoria, Tex.; **Louis M. Ayers,** foreman, Corpus Christi to Robstown, Tex.; **P. L. McGee,** superintendent, Humble Oil & Refining Co., Genoa to Picton, Tex.

Warren I. Allen, engineer, Stanolind Oil & Gas Co., Greggton to Carthage, Tex.; **William B. Hoffman,** superintendent, Celanese Corporation of America, Kingsville, Tex., to Mannington, W. Va.; **P. J. Natho,** superintendent, Pan American Production Co., Lockport, La., to Kountze, Tex.; **Robert M. Decker,** foreman, Pan American Production Co., Port Barre to Lockport, La.; **Jack Hainworth,** foreman, Continental Oil Co., Basile, La., to Powell, Wyo.; **George P. Lemoine,** engineer, Esso Standard Oil Co., Baton Rouge to Bunkie, La.

Irwin B. Murray, Jr., geologist, California Co., Houma, La., to El Dorado, Ark.; **Cline L. Chamberlain,** superintendent, Cities Service Refining Corp., Maplewood to Lake Charles, La.; **A. G. Burki,** engineer, Lion Oil Co., El Dorado, Ark., to Wink, Tex.; **C. C. Irby,** Sohio Petroleum Co., superintendent, Mount Pleasant, Mich., to Russell, Kans.; **James Helis,** engineer, Atlantic Refining Co., Philadelphia, Pa., to Dallas, Tex.; **LeRoy V. Hester,** engineer, Stanolind Oil & Gas Co., Ellinwood to Ulysses, Kans.

Joseph H. Lane, geologist, Bridgeport Oil Co., Wichita, Kans., to Kansas City, Mo.; **George H. Link,** engineer, Carter Oil Co., Purcell to Tulsa; **Albert M. Specht,** foreman, Atlantic Refining Co., Gladewater to Denver City, Tex.; **A. L. Point,** foreman, Ohio Oil Co., Henderson to Bivins, Tex.; **Julian F. Zellner,** engineer, Stanolind Oil & Gas Co., Odessa to Midland, Tex.; **V. B. Sullivan,** superintendent, Nicklos Drilling Co., Lake Charles to Eunice, La.; **P. M. Thompson,** foreman, The Texas Co., Minden, La., to Texarkana, Ark.; **James L. Price,** foreman, Gulf Research & Development Co., Laurel, Miss., to Minden, La.

Harry T. Sutherlin, engineer, Standard Oil Development Co., Colonia to Elizabeth, N. J.; **Richard Williams,** geologist, Seismic Engineering Co., Rawlins, Wyo., to Palestine, Tex.; **W. C. Rodgers,** engineer, Phillips Petroleum Co., Bartlesville, Okla., to Midland, Tex.; **V. V. Thomasson,** superintendent, Barnsdall Oil Co., Marlow, Okla., to Shreveport, La.; **Myron C. Metcalf,** geologist, Phillips Petroleum Co., Oklahoma City to Duncan, Okla.; **H. V. Watkins,** foreman, Sinclair Refining Co., Shawnee to Healdton, Okla.

DEATHS

Hugo F. Urbauer, 79, chairman of the board of Midwest Piping & Supply Co., Inc., St. Louis, died March 25 in Phoenix, Ariz.

Lee O. Smith, supervisor of the accounting department at Magnolia Petroleum Co.'s Beaumont, Tex., refinery, died March 18 in Beaumont.

Harl A. Foster, 47, division lubrication engineer for Gulf Oil Corp., Houston, died March 25 in Houston. Foster taught physics at Texas A. & M. College from 1922 until he joined Gulf in 1927.

John Boyd Carter, 58, independent oil operator, died March 25 in Houston. Carter aided in organizing Gem Oil Co. in 1932 and remained an officer of the company until 1943 when he became an independent.

E. J. Rial, Pennsylvania oil operator, died March 20 in Oil City, Pa.

Journal-Guide to MODERN REFINING PROCESSES 1940

Forty-four leading refining processes are presented in this special section with flow charts and discussions of operating principles

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Fluid

THE fluid catalytic cracking process employs a porous, finely divided catalyst having a high surface area to convert hydrocarbons ranging from kerosine through heavy gas oil into gasoline, distillate fuel oils, and light gases. Depending on the products desired the process may be designed and operated to convert 40 per cent or more of the charge into gasoline and lighter products. Conversion ranges generally used are from 50 to 80 per cent.

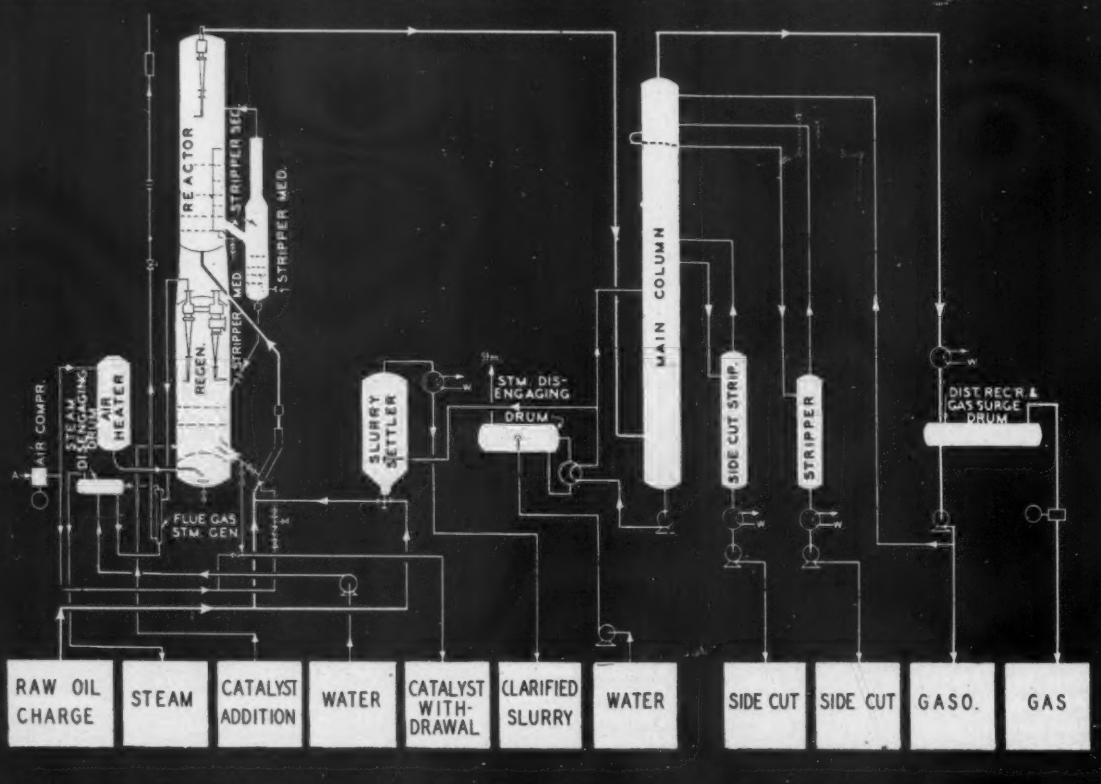
The raw oil feed, with or without preheat depending on the conversion level, is charged into a line where it contacts and is vaporized by hot regenerated catalyst. The oil vapers plus steam or gas diluent carry the catalyst up into the reactor. A distribution grid is positioned in the bottom of the reactor. The feed is cracked in the reactor catalyst bed and the products flow through a catalyst disengaging space and cyclone separator which removes the major portion of the entrained catalyst.

Fractionated Products

From the reactor the product stream flows to a main fractionation column where heavy cycle oil, light cycle oil, naphtha, unstabilized light gasoline, and gas streams are produced. The naphtha, light gasoline, and gas are processed in a gas-recovery system to obtain efficient recovery of propane-propylene, butane-butylenes and to prepare vapor-pressure gasoline. The light cycle oil is usually blended with a virgin stock to produce specification distillate fuel oil.

Part of the heavy cycle oil is recycled to the reactor to return catalyst fines to the cracking section. The net heavy cycle oil is usually blended with a heavy crude residue or asphalt to make specification fuel oil. Excess heat contained in the reactor outlet stream is removed by steam generation at the main fractionation column.

Since the cracking reaction deposits coke on the catalyst, thus temporarily reducing its activity, the catalyst must be regenerated. The catalyst is passed through successive stripping sections where it is contacted with upward flowing steam. This removes



Catalytic Cracking

the absorbed heavy hydrocarbons and reduces regeneration requirements as well as increasing product recovery. The stripped catalyst then enters the regenerator near the top of the catalyst bed.

Regeneration air is supplied below the distribution grid located in the bottom of the regenerator and flows up through the bed, thus burning the coke and effectively regenerating the catalyst. The hot regenerated catalyst then flows out of the regenerator, from the side and near the bottom, through a line which directs it to contact the raw oil feed and complete the catalyst cycle.

Reactor Placed Above Regenerator

It should be noted that the reactor is placed above the regenerator and that there is only one line which carries catalyst in a dilute phase and, therefore, at a relatively high velocity. The transfer from the reactor to the regenerator is entirely under dense phase conditions. This method has eliminated one large catalyst transfer line which existed in the previously designed units.

The accompanying table shows the yields obtained in pilot plant once through and recycle.

PILOT-PLANT RESULTS CHARGING 31° A.P.I. MID-CONTINENT GAS OIL (SILICA-MAGNESIA CATALYST)

Operation—	Once through	Recycle
Conversion per cent	65	80
Yields, volume per cent:		
Debutanized gasoline	53.0	66.0
Cycle oil	35.0	20.0
Butylenes	6.0	6.7
Butanes	6.0	5.3
Propylene	3.8	4.1
Propane	1.8	1.8
C_2 and lighter gas, weight per cent	2.3	2.7
10-lb.-R.v.p. catalytic gasoline	55.9	69.5
10-lb.-R.v.p. polymer gasoline	6.6	7.4
Total 10-lb.-R.v.p. gasoline	62.5	76.9
Octane No. of 10-lb. catalytic gasoline:		
Motor method clear (F-2)	79.8	79.1
+ 3 cc. TEL/gal.	86.1	85.0
Research method clear (F-1)	89.6	90.2
+ 3 cc. TEL/gal.	96.2	96.4

Principal modification of previous designs included in the fluid catalytic cracking unit is the utilization of a pressured regenerator. This permits several simplifications to be made as follows:

1. The reactor is located above the regenerator, thus permitting gravity transfer of catalyst in the dense phase from the reactor to the regenerator. This eliminates one large catalyst transfer line.

2. In relatively small-size units the reactor and regenerator may be combined in a single column, thus eliminating the structure required to support the reactor independently.

3. Combustion air passes countercurrently to the catalyst flow in the regenerator which povides for more efficient combustion.

An additional modification is the installation of grids in the reactor catalyst bed to improve the product distribution.

As a basis for discussion, the normal utility requirements here are estimated for the catalyst and fractionating sections of a 2,000-bbl. per stream day unit processing Mid-Continent gas oil at 60 per cent conversion in once-through operation. The utilities required to operate this equipment, are summarized in the accompanying table.

ESTIMATED NORMAL UTILITY REQUIREMENTS — 2,000 BBL. PER STREAM DAY CATALYTIC CRACKING UNIT

Basis: 60 per cent conversion Mid-Continent Gas Oil-Catalyst Section and Fractionator through Gas Compressor.

1. Steam:	Lb./hr.
Required (150 psi.):	
Pumps	3,000
Stripping	1,000
Total	4,000
Produced (150 psi.):	
From column bottoms steam generator	5,500
Net produced	1,500
2. Electricity:	Kw.
Lights and power	15
3. Fuel gas:	Millions of B.t.u./hr.
Required:	
Gas compressor	3
Air compressor	5
Total	8
Produced:	
After polymerization	31
Net produced	23
4. Cooling water (85° F. max. inlet):	Gal. per min.
Main condenser	250
Gas compressor cooling	150
Cycle oil coolers	100
Total	500

This process is licensed by Universal Oil Products Co., Chicago, and M. W. Kellogg Co., New York. Universal prepared this discussion and flow diagram.

Thermafor Catalytic Cracking

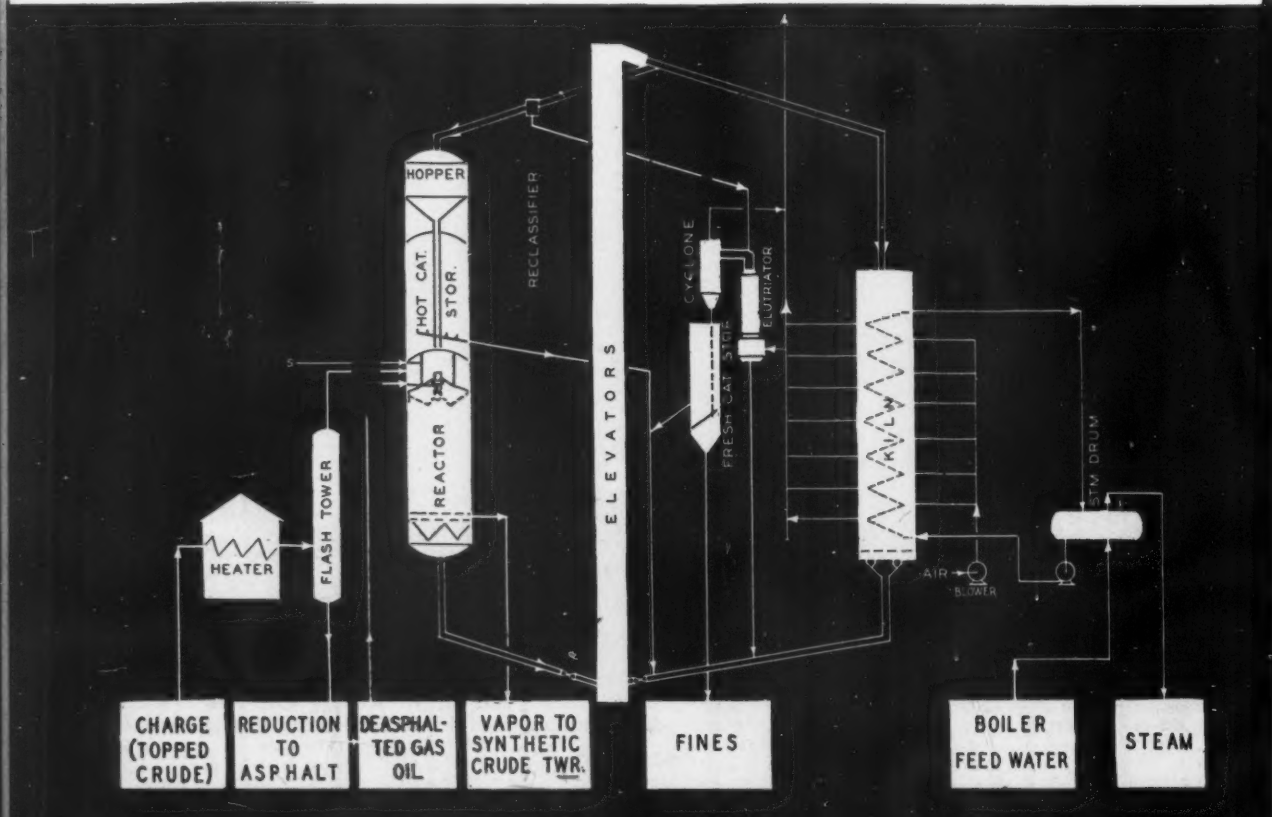
RECENT advances in the T.C.C. cracking process comprise the following: successful operation of commercial units in which nonvaporizable liquid material was charged to the reactors; proven commercial operation of a single elevator for transporting spent and regenerated catalyst; operation of equipment permitting concurrent flow of catalyst and oil charge; development of equipment for increasing the carbon-burning capacities of regenerating kilns; and the use of prehydration steam to reduce abnormal deactivation of natural clay catalyst when processing high-sulfur stocks.

Operations have been conducted on several commercial units in which nonvaporizable liquid material has been charged to the catalytic mass. In one instance, the liquid feed consisted of the 86 to 98 per cent fraction of mixed paraffinic crudes which was derived from a propane deasphalting operation. The liquid material is charged by means of a specially designed distribution nozzle. Equipment for charging nonvaporizable fractions has been installed in several existing plants and new units are being designed for this type of operation.

During the past year, two small-scale T.C.C. units were placed into operation utilizing only one elevator for the transportation of spent and regenerated catalyst. This operation is made possible through the use of an elevator having buckets containing three compartments. Spent catalyst, because of its lower temperature, is carried in the two outside compartments while regenerated catalyst is admitted to the center compartment. A new type valve has functioned extremely satisfactorily in the control of catalylst flow into each compartment. Neither elevator has been responsible for any offstream time and following an 8-month run, the elevator of one of the units was inspected and found to be in excellent condition.

Several T.C.C. units have been modified to permit the contacting of the oil charge with catalyst in concurrent flow. This type of operation permits a more efficient utilization of the heat contained in the two media, thereby resulting in higher average reactor temperatures. This operating feature has been reflected in higher motor and research octane numbers of the catalytic gasoline. The apparatus employed for disengaging the outgoing oil vapors from the catalyst has functioned satisfactorily with no entrainment of catalyst into the fractionating equipment.

To increase the coke-burning capacity of T.C.C. units, equipment has been designed to effect a more



uniform distribution of catalyst throughout the cross-section of the regenerating kilns. The increased carbon-burning capacities have permitted accompanying increases in the severity of reactor operating conditions.

The use of prehydration steam in operations conducted on natural clay catalyst has two advantages: (1), due to the heat of hydration, a higher reactor catalyst inlet temperature may be obtained and, (2), the deactivation of clay catalyst when processing high-sulfur stocks may be retarded. The higher temperature at which the catalyst enters the reactor is useful in obtaining a higher average reactor temperature, thereby resulting in increased severity of operation and the production of a catalytic gasoline having a high research octane number.

This process is licensed by Houdry Process Corp., Philadelphia.

TABLE 1—RESULTS OF CRACKING EAST TEXAS HEAVY GAS OIL UNDER VARYING CONDITIONS, BY THE T.C.C. PROCESS

Operating conditions:										
Space velocity—V./hr./V.	0.52	0.51	0.50	1.0	0.98	0.99	0.97	1.98	1.99	2.04
Average reactor temp., °F.	775	820	890	805	870	885	955	870	905	906
Average reactor pressure, psig.	10	10	10	10	10	10	10	10	10	10
Process steam, wt. % charge	13.9	9.5	9.4	13.9	10.1	9.8	9.6	9.6	9.7	9.5
Conversion* (100—Vol. % total catalytic gas oil)	43.1	52.9	67.7	40.8	53.5	56.6	70.2	43.1	47.8	59.3
Yields, % on fresh feed:										
Debutanized motor gasoline, vol. %	36.2	42.2	41.5	35.0	39.7	41.5	39.8	34.9	35.6	36.6
Total B-B, vol. %	7.9	9.4	15.9	7.1	10.2	12.7	14.1	9.3	10.9	15.1
Light catalytic gas oil, vol. %	29.9	....	20.6	29.2	25.6	....	19.0	27.2	....	....
Heavy catalytic gas oil, vol. %	27.0	....	11.7	30.0	20.9	....	10.8	29.7	....	....
Liquid recovery, C_4 plus, vol., %	101.0	98.7	89.7	101.3	96.4	97.6	83.7	101.1	98.7	92.4
Dry gas, C_2 and lighter, wt. %	3.1	5.4	13.0	2.3	7.5	6.8	17.8	4.0	6.2	12.0
Motor gasoline, 10-lb. R.v.p., vol. %	39.1	45.1	43.7	37.6	42.8	44.5	42.2	37.4	37.9	39.0
Excess B-B, vol. %	5.0	6.5	13.7	4.5	7.1	9.7	11.7	6.8	7.6	12.7
Light products:										
n-Butane, vol. %	1.7	1.9	3.2	1.2	1.5	2.2	1.8	1.7	1.5	2.9
Isobutane, vol. %	4.4	5.2	7.9	4.5	5.4	7.0	6.0	5.1	5.5	5.7
Butenes, vol. %	1.8	2.3	4.8	1.4	3.3	3.5	6.3	2.5	3.9	6.5
Propane, wt. %	0.8	1.9	3.4	0.8	1.6	2.1	3.2	1.1	1.6	2.2
Propene, wt. %	1.4	2.1	3.5	0.9	2.2	2.2	4.7	1.8	2.7	4.7
C_3 and lighter, wt. %	0.9	1.4	6.1	6.0	3.7	2.4	9.9	1.1	1.9	5.1
Cracking efficiency†	90.6	85.4	64.5	92.1	80.0	78.5	60.1	86.8	79.4	65.8
Catalytic motor gasoline:										
°A.P.I. gravity	55.3	56.2	55.5	57.0	56.5	55.9	55.4	56.0	55.0	53.6
Distillation, A.S.T.M., °F.:										
I.b.p.	96	95	93	101	94	89	96	99	97	96
10%	135	126	125	131	122	121	120	129	125	122
50%	268	241	241	257	240	240	223	244	244	237
90%	388	398	380	385	390	396	386	385	390	387
End point	425	426	433	423	425	438	422	424	425	430
R.v.p.	10.2	9.9	9.6	9.7	10	10.2	10.5	10	10	10
Sulfur, wt. %	0.06	....	0.04	0.06	....	....	0.06	0.07	....	....
Octanes:										
A.S.T.M. clear	76.2	77.7	80.4	76.2	77.0	78.9	81.0	79.0	80.8	80.8
Research clear	85.0	87.0	92.0	84.1	....	90.2	94.4	89.9	91.7	94.3

*Catalyst, synthetic bead. †$\left(\frac{\text{10 psi. R.v.p. motor gasoline}}{\text{Conversion}} \times 100\right)$.

TABLE 2—RESULTS OF T.C.C. CRACKING AND PROPERTIES OF PRODUCTS FROM MICHIGAN CRUDES FROM REED CITY AND ADAMS FIELDS

	Reed City						Adams					
	Rd. Cr.	TSB	TSO	Gaso.	Dist.	STB	Rd. Cr.	TSB	TSO	Gaso.	Dist.	STB
Gravity, °A.P.I.	28.5	15.2	31.8	62.7	32	24.0	18.9	11.1	28.0	61.4	30	19.0
Color	Green	Black	5	30+	1	4½	Black	Black	7	27	2	4½
Pour, °F.	+30	+35	....	....	0	+60	+5	+60	....	....	0	+50
Dist., A.S.T.M.:												
I.b.p., °F.	446	....	....	96	442	478	485	....	....	90	435	470
10 per cent Rec. at °F.	575	....	....	118	472	568	610	....	....	114	492	570
20 per cent Rec. at °F.	625	....	....	132	478	586	650	....	....	141	500	590
30 per cent Rec. at °F.	660	....	....	150	482	608	(‡)	....	....	163	510	603
40 per cent Rec. at °F.	(†)	....	....	176	486	628	....	....	....	183	515	616
50 per cent Rec. at °F.	....	....	....	208	494	640	....	....	....	208	520	628
60 per cent Rec. at °F.	....	....	....	240	500	658	....	....	....	233	530	640
70 per cent Rec. at °F.	....	....	....	280	510	678	....	....	....	268	540	653
80 per cent Rec. at °F.	....	....	....	320	520	738	....	....	....	312	555	680
90 per cent Rec. at °F.	....	....	....	362	540	740	....	....	....	350	576	706
E.p., °F.	....	....	....	402	584	760	....	....	....	390	630	728
Octane, A.S.T.M.	....	....	....	78	....	....	....	....	....	78	....	....
Octane, Research	....	....	....	87	....	....	....	....	....	87	....	....
Gum, A.S.T.M., mg./100 ml.	....	....	....	1.8	....	....	....	....	....	2.2	....	....
Gum, Cu. Dish, mg./100 ml.	....	....	....	5.4	....	....	....	....	....	12.9	....	....
Induction period, hours	....	....	....	22+	....	....	....	....	....	22+	....	....
Sulfur, per cent weight	0.70	0.855	0.611	0.046	0.269	0.597	0.85	0.976	0.558	0.061	0.385	0.553
Carbon residue, per cent weight	1.5	8.6	0.32	....	0.014	0.14	8.0	12.9	1.17	....	0.01	0.14
Car. Res. on 10% Btms., % weight	....	....	....	....	0.08	2.65	....	....	....	....	0.13	2.10
Viscosity S.U. at 100° F. sec.	200	....	....	....	34.8	53.0	1,000	....	....	....	34.7	50.8
Viscosity S.F. at 140° F. sec.	....	221	....	....	....	....	....	450	....	....	....	....
Kinematic visc. at 100° F. centistokes	....	....	....	....	2.48	7.74	....	....	....	....	2.5	7.80
Flash P.M., °F.	....	....	....	....	195	....	....	....	....	....	170	....
Flash, COC, °F.	250	370	....	....	....	250	295	470	....	....	....	270
Aniline point, °F.	....	....	....	....	142	162	....	....	....	....	130	146
Diesel index	....	....	....	....	46.6	39.6	....	....	....	....	39.8	31.4
Reid vapor pressure, psi.	....	....	....	10	....	....	....	....	....	10	....	....

*Operation of this T.C.C. unit has changed day to day. These tests represent spot checks on stream samples from time to time and not a systematic program to obtain representative tests for a definite type of T.C.C. operation. Rd Cr. = Reduced Crude; TSB = Tar Still Bottoms; TSO = Tar Still Overhead; STB = Steamed Tar Bottoms. †Cracking at 37.5 per cent. recovered. ‡Cracked at 21 per cent recovered.

Cycloversion Catalytic Cracking

THE Perco Cycloversion process embodies a fixed-bed principle of catalytic cracking in which no appreciable loss of catalyst occurs through the formation of fines by abrasion. Equipment for the circulation, separation, and recovery of catalyst from the process or reactivation gases is not required. The natural bauxite catalyst employed is capable of regeneration an indefinite number of times.

Fresh or recycle feed is preheated to about 980°-1,000° F. in a radiant section and then admixed with a small quantity of steam diluent in the convection bank. The steam reduces carbon deposition on the catalyst, assists in vaporizing the charge, and improves ultimate octane rating. The superheated oil-steam mixture passes to the catalyst chamber (10-85 psig.), where catalytic cracking is obtained in process cycles of 2 to 10-hour periods. The total chamber product passes through the oil-water-vapor separator where the condensed water is withdrawn, the vapors go to the gas-recovery plant, and the liquid hydrocarbon condensate to fractionation.

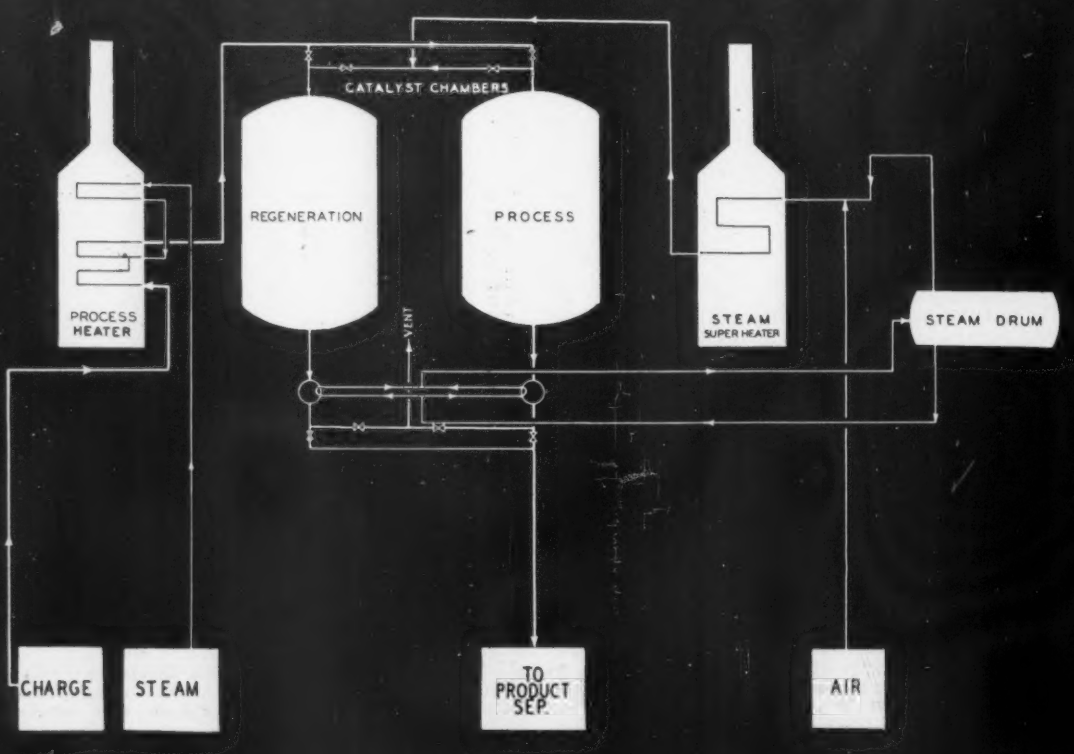
Simultaneously with the processing of the gas oil charge in the on-stream reactor, the alternate chamber is undergoing catalyst regeneration.

LOW-PRESSURE (10-PSI.) CYCLOVERSION OF MID-CONTINENT (WESTERN KANSAS) GAS OIL

Feed stock:	
Gravity, A.P.I.°	32.2
10 per cent (vacuum)	604
90 per cent (vacuum)	75[illegible]
Aniline point, °F.	181
Catalytic gasoline, C_5-400° F.:	
Gravity, A.P.I.°	54.9
Reid vapor pressure	6.6
A.S.T.M. octane number	81.1
+ 3 cc. TEL	84.7
Research octane number	94.5
+ 3 cc. TEL	98.0
Yields, per cent of charge:	
Catalytic gasoline, C_5-400° F., Vol. per cent	33.2
10-lb. R.v.p., gasoline, Vol. per cent*	42.9
Propylene, Vol. per cent	4.2
Butylenes, Vol. per cent	5.6
Catalytic recycle 400° F.+, Vol. per cent	50.7
Carbon, weight per cent	2.3
Conversion, single pass, Vol. per cent	49.3

*Butanized and includes potential catalytic poly gasoline.

This process is licensed by Phillips Petroleum Co., Bartlesville, Okla.



Houdry Catalytic Cracking

DURING the past year, a definite improvement in the design of the reactors employed in the Houdry fixed-bed process has been commercially proven. The improvement embodies redesign of the vapor and air-distributing elements and salt-cooling tubes.

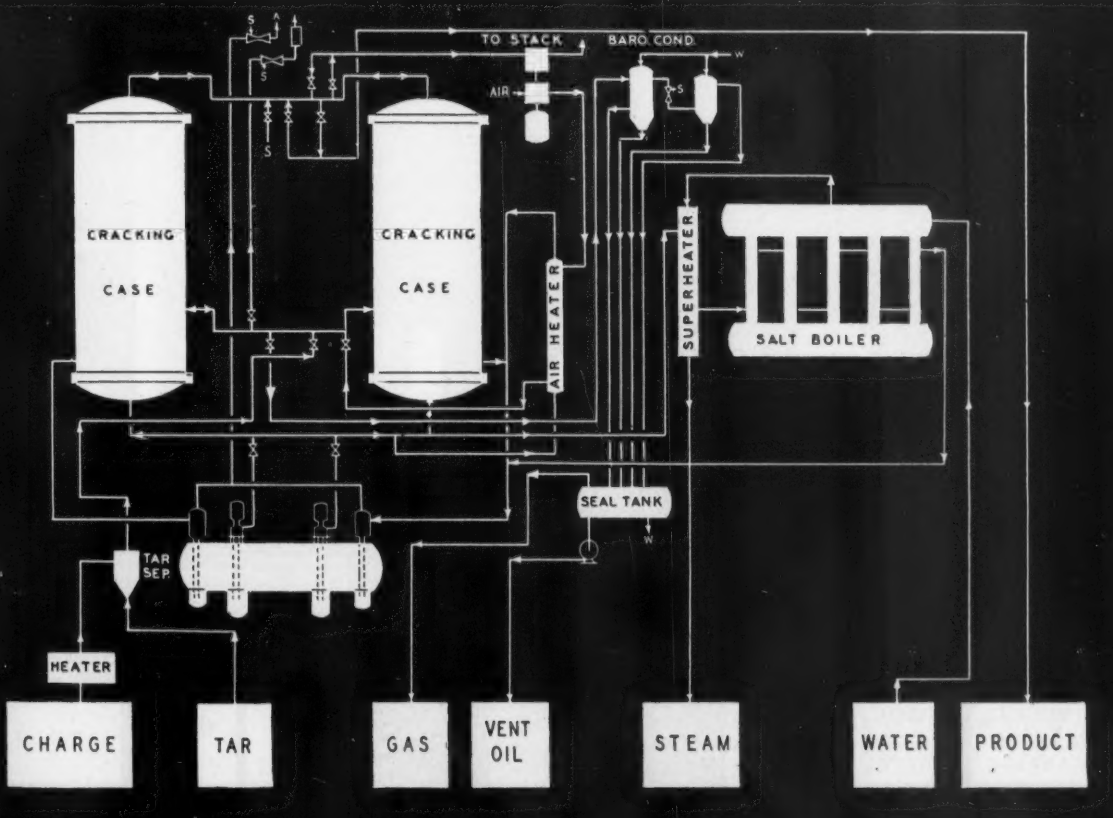
Of particular significance in the new design is the marked reduction in time required to remove catalyst from the reactors. Commercial experience indicates that the catalyst may be changed in 25 per cent of the time that was previously consumed. The onstream efficiencies of the plants have been improved and, therefore, the over-all production of catalytic gasoline and other products likewise increased.

In the new design, because of their separation from the salt-cooling tubes, all of the elements for distributing and collecting air and oil vapors from the catalytic mass may be removed through the top of the reactors. With this arrangement these tubes may conveniently be removed at every catalyst change, thereby permitting inspection and cleaning of the distributing orifices. By replacing all of the distributing elements with cleaned orifices, the efficiency of contact between the oil-vapor charge and catalyst is improved, which is estimated to yield 2 to 3 per cent more gasoline during the life of the catalyst.

In addition, the distributing elements, salt-cooling tubes, and fins have been made of heavier material, thus increasing their life and permitting operation at more severe conditions. The increased dimensions of the heat-transfer fins result in a greater rate of heat transfer and although more severe conditions are employed, the tubes do not operate at temperatures higher than heretofore. The increased severity of operation has been reflected in the octane numbers of the catalytic gasoline produced.

Design of the new distributing and cooling elements readily may be adapted to existing reactors and no changes are required in the auxiliary equipment. The regulation of the sequence of onstream, evacuation, and regeneration periods of each reactor is controlled by cycle timers and systems of motor-operated valves that were previously employed.

This process is licensed by Houdry Process Corp., Philadelphia.



Suspensoid Catalytic Cracking

SUSPENSOID catalytic cracking is fundamentally a type of catalytic cracking. It differs from the standard fluid operation in the use of relatively small quantities of catalyst and relatively high pressures and temperatures. The process has been developed to utilize conventional thermal cracking equipment with the minimum of additional facilities.

The features of the Suspensoid process are superimposed over normal thermal cracking procedures by the addition of approximately 2 lb. of finely divided catalyst per barrel of coil charge, the selection of coil conditions to insure complete vaporization in the cracking zone, and the filtration of spent catalysts from the tar resulting from the usual quenching and flash-tower operations.

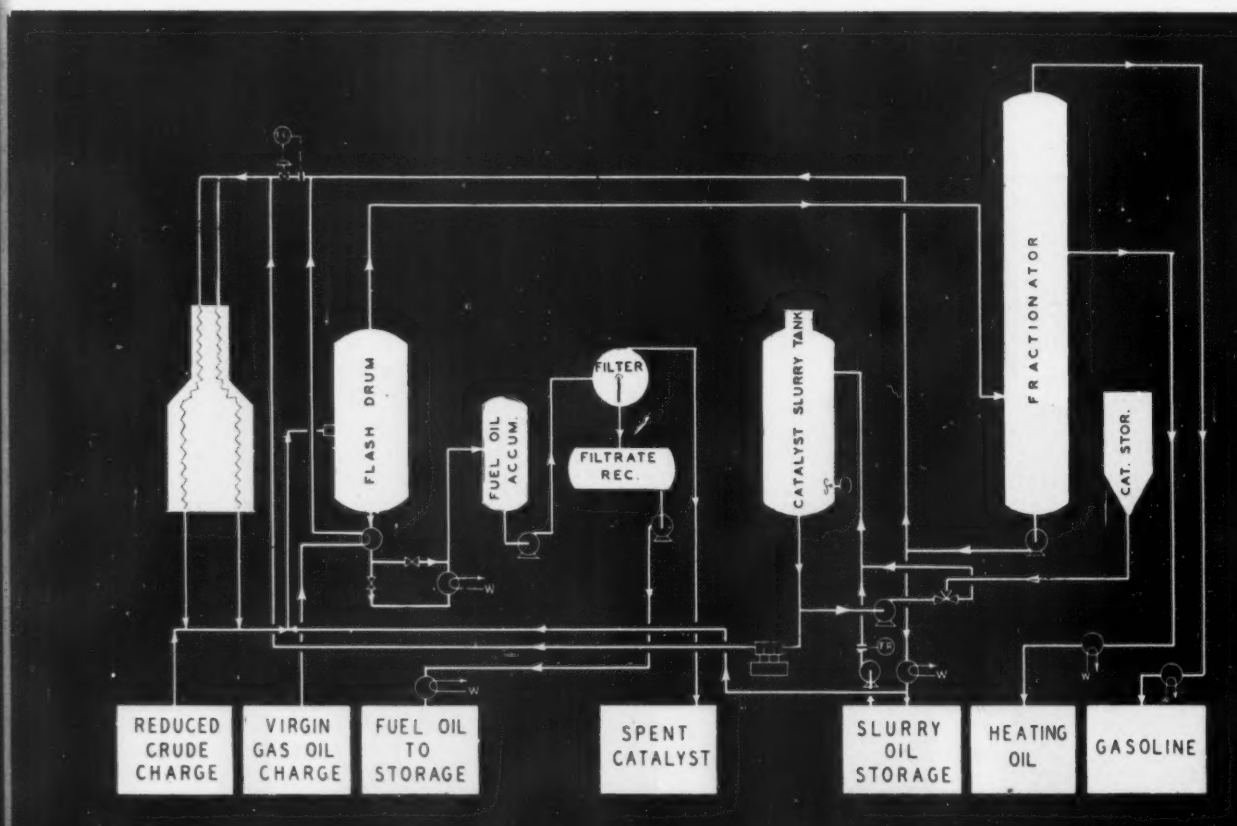
Reduced crude or gas oil may be charged to the cracking operation as long as the usual precautions are taken to insure clear distillate stocks as charge to the coil. Naphtha, water, or light hydrocarbons may be used to facilitate complete vaporization at the temperatures and pressures required. Coil outlet temperatures of 1,030°-1,100° F. and pressures from 150-880 psi. have been employed.

Water has no effect on cracking operation, but some gas reversion has been found where light hydrocarbons are used. The operation may be either once through or recycle but since the conversion per pass is in the order of 85 per cent, recycling is not too important. For this reason, even though a greater heat input per unit of coil charge is required at a higher temperature level, the total heat load on the furnace is generally less than for the comparable thermal operation to ultimate yield.

Typical thermal cracking furnaces are generally satisfactory for Suspensoid operations. It is desirable to have low-chrome steel in the soaker section of the furnace and special streamlined return-bend headers to keep down erosion at that point under the most extreme conditions. Under the conditions of operation it is essential to maintain the flow of catalyst to the coil to prevent coking. A special triplex pump designed to eliminate excessive wear in the packing gland is used for injecting a catalyst slurry in the coil charge. Back pressure is held on the coil by means of a venturi-type orifice located at the inlet to the flash tower. The catalyst is removed from the tar bottoms by means of a conventional Oliver Precoat rotary filter.

Suspensoid cracking will produce approximately the same yield of 10-lb. R.v.p. 400° F. end-point gasoline as does thermal cracking, but with an octane number above thermal of approximately 7 to 8 points on Motor method and 11 to 12 by Research.

This process is licensed by Imperial Oil Co., Ltd., Toronto.



Perco Catalytic Reforming

THE Perco catalytic reforming process provides an economical means of both desulfurizing and catalytically reforming cracked and straight-run naphtha.

Normal operating conditions include chamber pressures of 50-100 psig., top-bed chamber temperatures approximating 1,000° F., and process cycles of 24 hours or more. The feed is vaporized and then superheated in the process heater prior to passing through the catalyst tower. The effluent vapors pass through the feed-product heat exchangers, thence to the rerun and stabilizing towers from which the finished gasoline is sent to storage.

PENNSYLVANIA STRAIGHTRUN GASOLINE

62.2° A.P.I. gravity; 100°-400° F. boiling range

	Raw feed	Cat. reformed*
A.S.T.M. octane number	48.8	61.5
+ 1 cc. TEL	57.3	71.0
+ 3 cc. TEL	67.1	79.6
Research octane number	49.6	65.8
+ 1 cc. TEL	57.9	74.4
+ 3 cc. TEL	68.7	83.5
R.v.p. at 100° F.	8.5	10.2
Total sulfur, per cent	0.055	0.005

MID-CONTINENT (KANSAS) CRACKED-STRAIGHTRUN GASOLINE

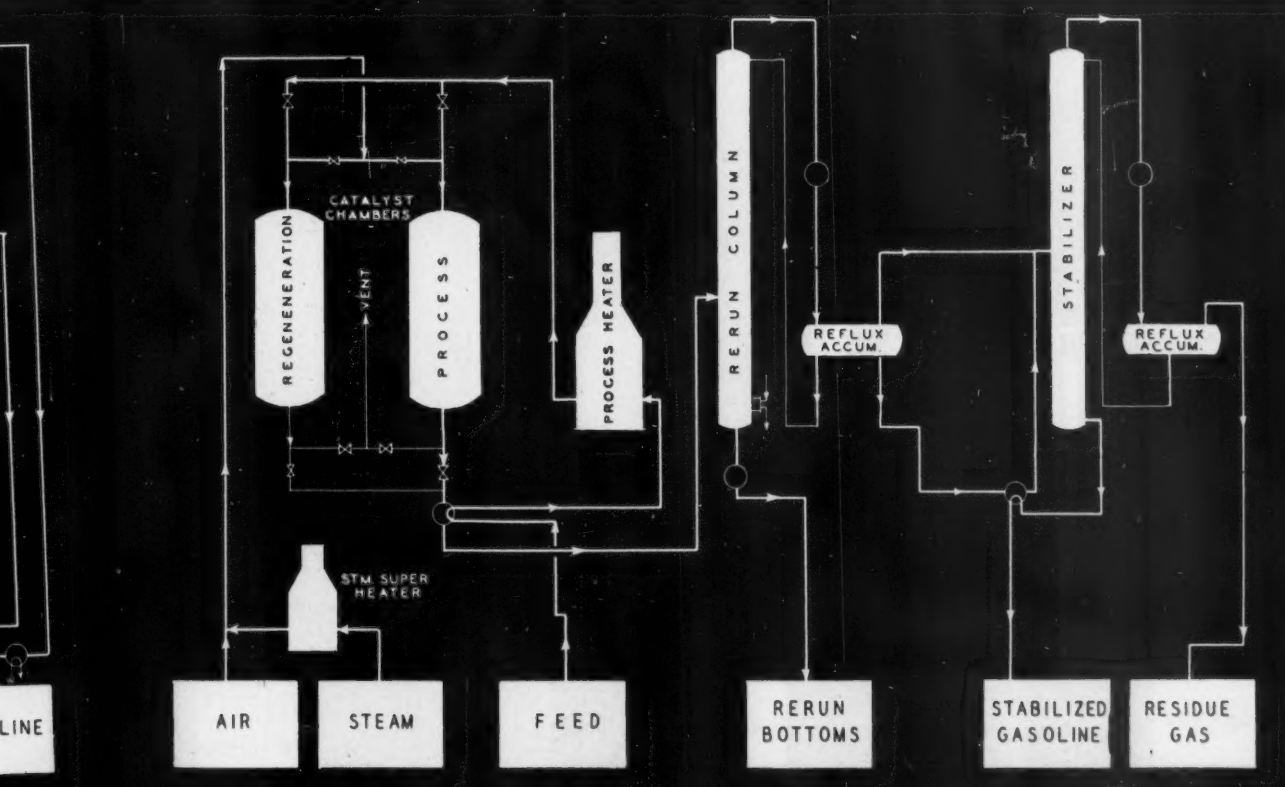
61.7° A.P.I. gravity; 121°-403° F. boiling range

	Raw feed	Cat. reformed*
A.S.T.M. octane number	59.6	70.8
+ 1 cc. TEL	68.4	78.8
+ 3 cc. TEL	75.6	83.6
Research octane number	63.2	75.3
+ 1 cc. TEL	71.4	83.6
+ 3 cc. TEL	81.2	88.8
R.v.p. at 100° F.	4.4	10.6
Total sulfur, per cent	0.039	0.031

*Catalytically reformed products are C_5 and heavier gasolines and do not contain potential poly gasoline from polymerization of C_3 and C_4 olefins produced.

The process may be operated either at catalytic reforming or catalytic desulfurizing conditions. Note below the appreciable increase in "jump" octanes, or the spread between A.S.T.M. and Research values. This feature is of extreme interest to refiners having only thermal-type equipment.

This process is licensed by Phillips Petroleum Co., Bartlesville, Okla.



Catalytic Polymerization

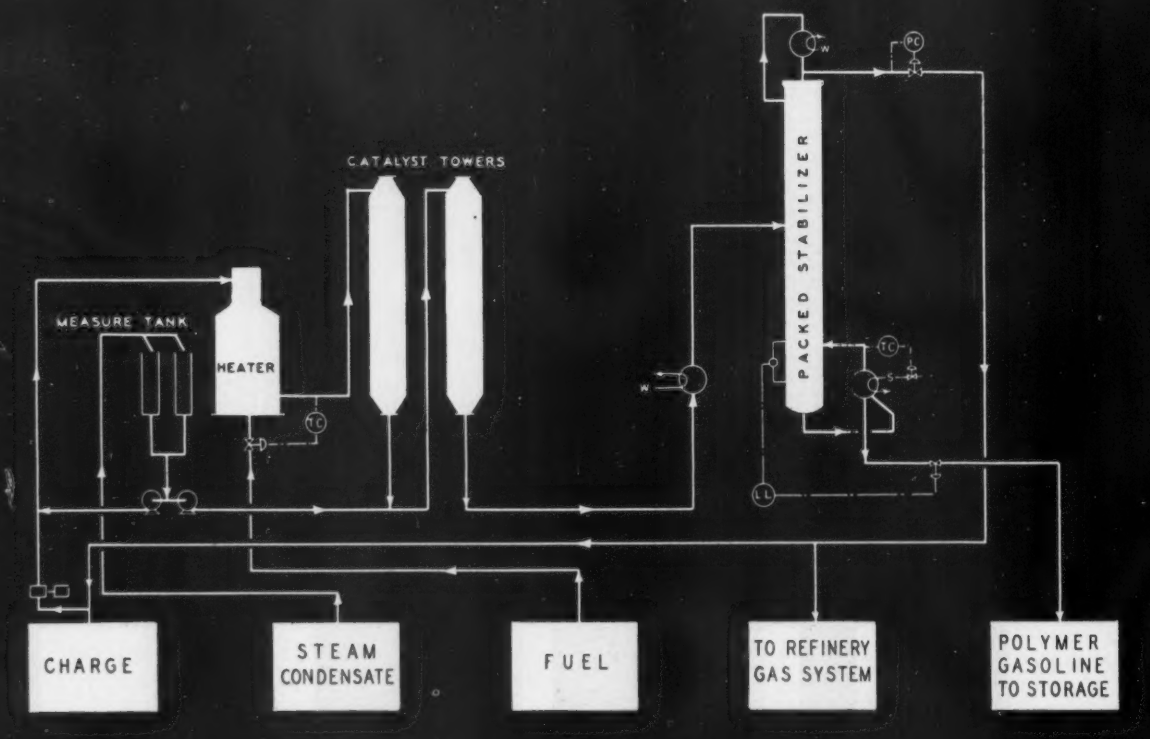
Chamber Type

THE U.O.P. catalytic polymerization process is used for the polymerization of normally gaseous olefins formed as a byproduct of all petroleum cracking reactions to produce a high-grade motor fuel. The process is a valuable adjunct to the refiners' cracking processes because it makes possible an increased production of gasoline per barrel of crude from a feed which may otherwise be used only as refinery fuel. The polymer so produced is a highly unsaturated gasoline which exhibits a high blending octane number when used in small percentages of the finished-gasoline blend.

The polymerization process may be operated on a vapor or liquid feed containing propylene or butylenes alone or in admixture. The type of operation chosen depends on the source of feed and the type of product desired.

Generally the process is used to polymerize propylene and butylenes in admixture so as to produce the maximum quantity of polymer gasoline. However, if it is desired to produce a saturated, high-octane gasoline for use as an aviation fuel, the process may be used to polymerize butylenes in the absence of other olefins to yield a product which on hydrogenation will rate 90-95 octane number feed. This latter operation is known as selective polymerization whereas the former is designated nonselective operation.

Propylene can also be polymerized separately to produce motor polymer or a product which is rich in C_6, C_9, or C_{12} hydrocarbons which are valuable raw materials for the chemical industry. In recent years the butylenes produced in normal refinery operations have become more valuable when used for other purposes and many plants have, therefore, been operated for the polymerization of residual propylene.



Catalytic Polymerization

Reactor Type

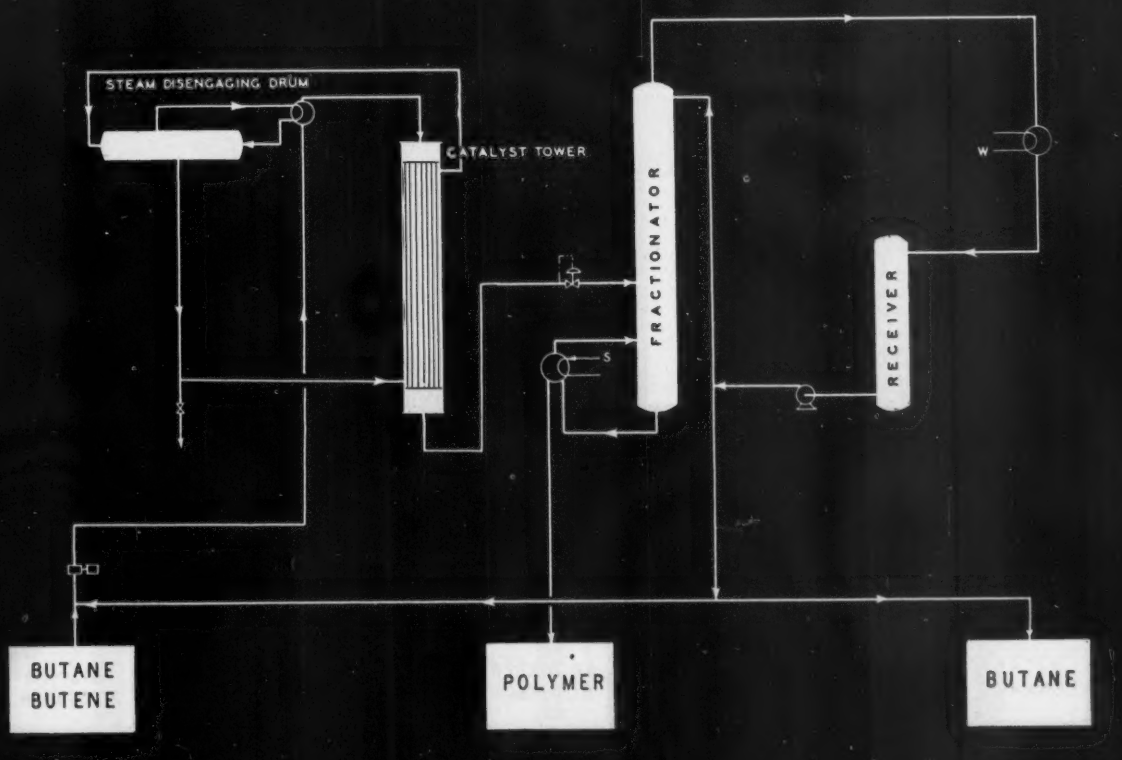
The U.O.P. catalytic polymerization process consists of contacting the olefin-bearing feed with a catalyst at pressures from 150 to 1,200 psi. and temperatures from 350° to 475° F. The conditions employed will depend on the feed stock processed and the type of product desired.

The types of units, chamber and tubular reactor, currently are being used to carry out the polymerization reaction. The choice of design depends somewhat on the properties of the feed which is processed.

The chamber-type unit has been the most generally used design. In this unit the pelleted catalyst is contained in one or more vertical chambers each having multiple catalyst beds 5 to 10 ft. in depth. Since the polymerization reaction is exothermic and the reactor system is essentially adiabatic, an increase in temperature of reactants occurs as they travel through the catalyst beds. This temperature rise is controlled within a range considered most effective for good olefin conversion and catalyst life by diluting fresh feed with recycle hydrocarbons which have been through the catalyst chambers.

With feeds having relatively high olefin contents such as are obtained from catalytic cracking units, the recycle stream in chamber units may become excessive. Therefore, the tubular reactor-type units are used for these highly olefinic feeds. In these units a smaller temperature rise occurs in the catalyst bed because the catalyst is loaded in a vertical heat exchanger which generates steam used for preheating of the feed. Although the reactor installation is more complicated than the chamber unit there is a compensating saving in catalyst life and in equipment required to handle the recycle stream.

This process is licensed by Universal Oil Products Co., Chicago.



Catalytic Dehydrogenation

THE U.O.P. catalytic dehydrogenation is a fixed-bed catalytic process for removal of hydrogen from a saturated hydrocarbon, to form the corresponding olefin or diolefin as principal products.

Essentially, the dry normal butane charge is heated to reaction temperature and passed over a suitable catalyst contained in vertical reactor tubes (1,000° to 1,100° F. and 10 to 50 psi.). Heat is drawn from an externally circulating flue-gas stream to supply that required in the endothermic dehydrogenation reaction. The catalyst reactivating system is similar to and runs parallel to the processing system. The carbon is burned without reaching excessively high catalyst temperatures by passing reactivating gas of controlled oxygen content in sufficient volume over the catalyst.

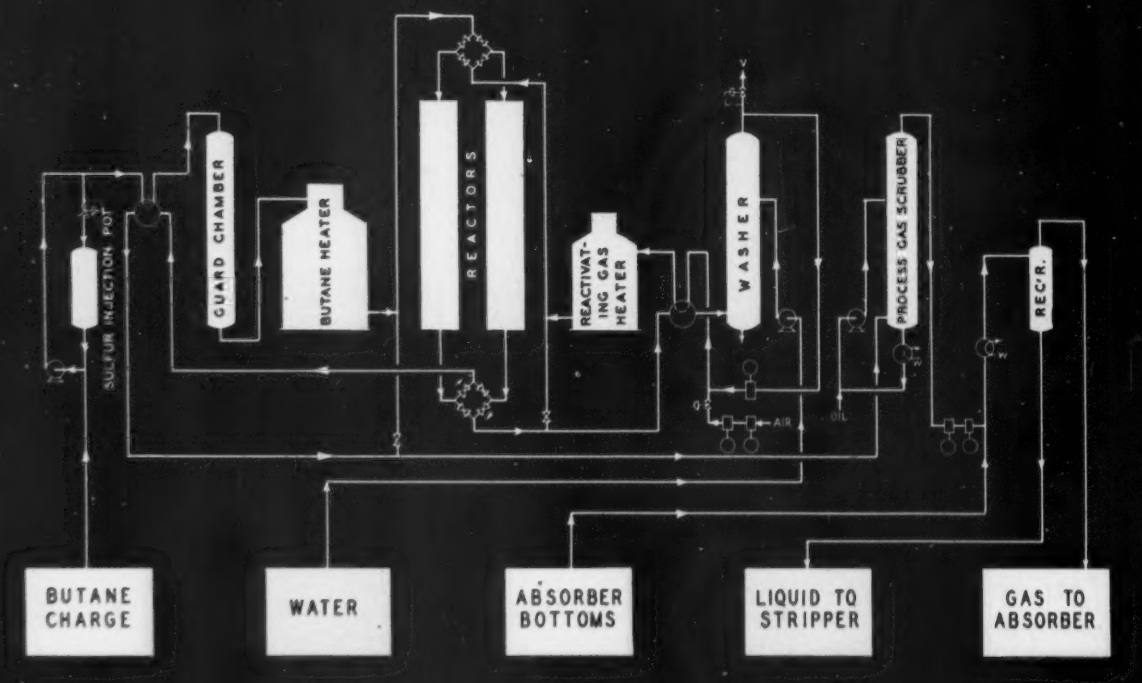
In the commercial catalytic dehydrogenation of normal butane the process is normally carried out at conversions of about 30 per cent per pass. Unconverted butane is returned to the system so that ultimate yield of butylenes is 75 to 80 per cent by liquid volume.

The butane-butylene fraction, as usually practiced, has been processed in alkylation or polymerization units in which the butylenes are converted to alkylate or polymer for high-octane-gasoline production. The unreacted butane is recovered and recycled to the dehydrogenation unit.

Approximate direct operating costs for the catalytic dehydrogenation of 1,000 bbl. per day of normal butane are listed below. These costs cover the dehydrogenation step only. Additional costs are incurred should it be desirable to obtain further concentration of the butylenes.

Item—	Cents per gallon of butylene
Operating labor, supervision, laboratory, etc.	0.95
Maintenance, labor, and materials	0.60
Utilities	0.70
Taxes, insurance, administration, general overhead	0.70
Catalyst	0.20
Royalty	0.50
Total	3.65

This process is licensed by Universal Oil Products Co., Chicago.



Sulfuric Acid Alkylation

ALKYLATION as practiced by the petroleum industry is the catalytic method of combining an isoparaffin (usually isobutane) with an olefin (propylene, butylene, or amylene) to produce saturated isocompounds. The product of the reaction—alkylate—has a high octane rating and is therefore employed as a blending agent in aviation and motor gasoline.

The olefin is dissolved in concentrated sulfuric acid and violently agitated with an excess of isobutane at a temperature of 35°-45° F. and a pressure several pounds above atmosphere. Under these conditions, the reaction proceeds readily.

Since the reaction is exothermic, the heat of reaction is removed by autorefrigeration. Refrigeration is also required to remove the heat imparted by the emulsion pumps. Conditions are maintained at the bubble point of the mixture and a sufficient amount of hydrocarbon is allowed to vaporize to cool the mixture to the control temperature. The vaporized hydrocarbons are compressed, condensed, and returned to the system.

The product of the reaction is separated from acid in the center section of the combination reactor-settler and after caustic treatment is pumped to the isobutane tower. Isobutane overhead from this tower is returned to the process while the alkylate bottoms containing any normal butane present in the original feed is sent to a debutanizer tower where butane is removed as an overhead product. The alkylate bottoms are usually separated in a rerun tower into a light aviation cut and a heavy alkylate.

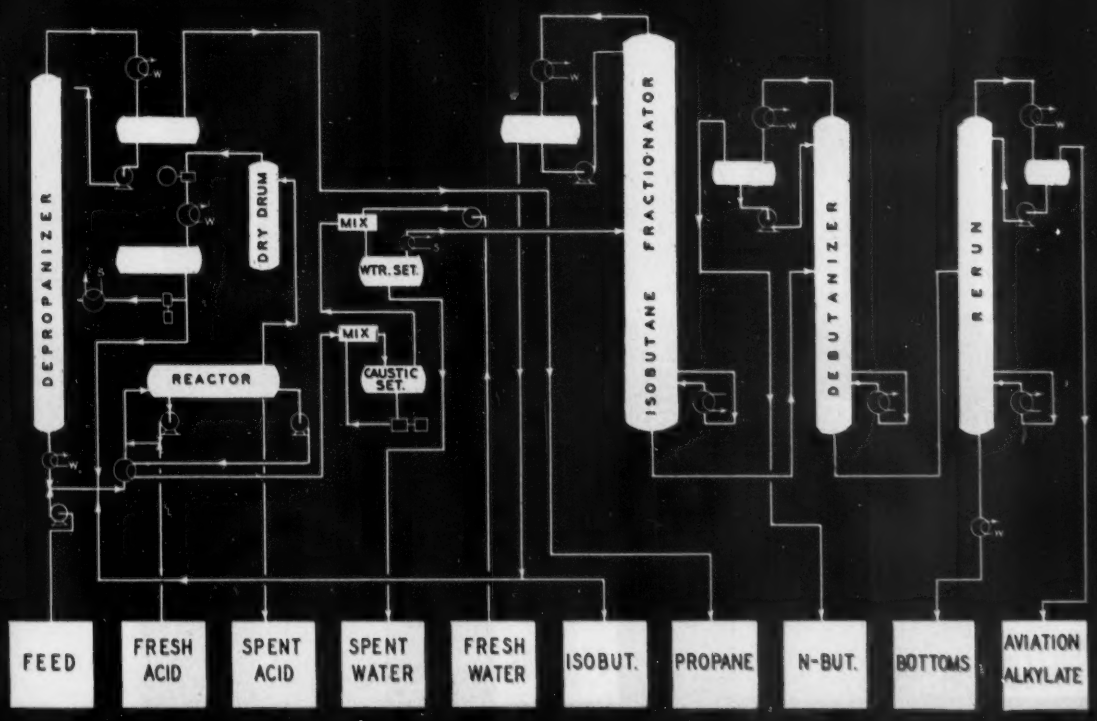
The lower the temperature at which the reaction is carried out, the better the quality of the alkylate and the lower the acid consumption.

The lower the concentration of olefin, the lower is the tendency toward polymerization and the higher the tendency toward alkylation. A low olefin concentration is effected by circulating large volumes of emulsion. Normal butane does not enter into the reaction and is a harmful diluent.

While 98 per cent acid is usually added to the process, more important is the average strength of the acid contained in the reactor.

Most of the alkylation units in this country were designed for operation on butylenes, but today many units are operating on propylenes. Butylenes give the best product quality and the lowest acid consumption. The same units can also be used for alkylating amylenes.

The alkylation processes (sulfuric acid and hydrofluoric) are licensed variously by M. W. Kellogg Co., New York; Universal Oil Products Co., Chicago; Phillips Petroleum Co., Bartlesville, Okla. Kellogg prepared this discussion and flow diagram.



HF Alkylation

THE HF (hydrofluoric acid) alkylation process is a catalytic method which combines olefins, such as propylene, butylenes, and amylenes with an isoparaffinic hydrocarbon, usually isobutane, to form a mixture of branched-chain hydrocarbons of higher molecular weight known as alkylate.

The alkylate so produced is a mixture of saturated, stable isoparaffinic hydrocarbons distilling in the gasoline range. It has an A.S.T.M. octane number from 88 to 93, and good tetraethyl lead susceptibility.

The U.O.P. hydrofluoric alkylation process is carried out essentially as follows: Fresh feed, prepared by absorption and fractionation of the light gases from catalytic cracking and related processes, is dried by fractionation or by means of a desiccant. The stream then flows to the reactor where intimate mixing with the acid catalyst and recycle isobutane is provided under sufficient pressure to keep the mixture in liquid state. Normally, the ratio of acid to hydrocarbon in the reactor is 1 to 1 and the ratio of isobutane to olefin entering the reactor 5 to 1 to 10 to 1.

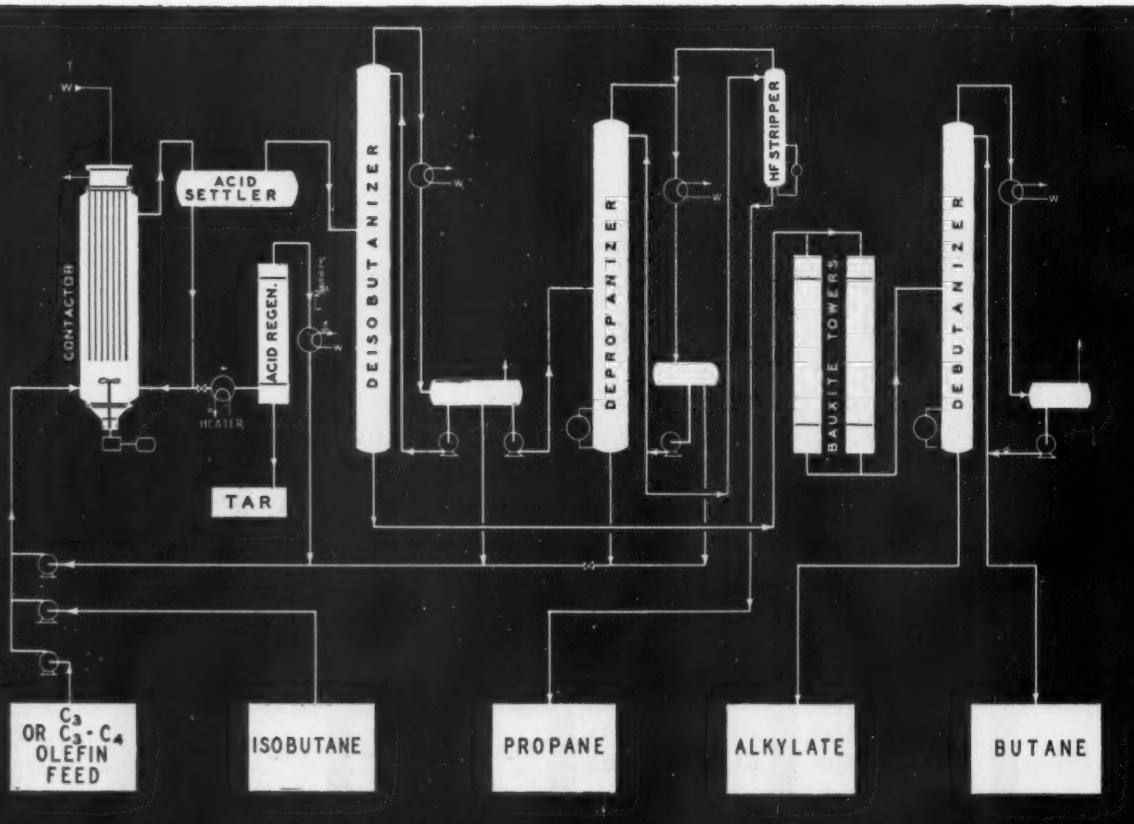
Temperatures used in the reaction zone will be about 100° F. Means are provided for cooling of the reaction mixture since the alkylation reaction is exothermic.

The reactor effluent, consisting of unreacted light hydrocarbons, alkylate, and acid, is permitted to separate into hydrocarbon and acid phases. Substantially complete separation is obtained by settling and the settled acid is recycled to the reactor. The hydrocarbon phase will contain some dissolved acid which is removed by fractionation. The dissolved hydrofluoric acid is recovered as an overhead product in fractionation and is returned to the reaction system.

Since some heavy polymers are formed in the alkylation reaction, the catalyst must be either purified or replaced. The heavy polymers may be removed from hydrofluoric acid by fractionation and stripping, which continuously returns a purified acid to the reaction zone.

After removal of the dissolved acid, the hydrocarbon stream is further fractionated to separate the unreacted hydrocarbons, an isobutane recycle stream, rerun alkylate, and a heavy alkylate which will be a small percentage of the total alkylate produced depending on the end point desired on the rerun alkylate.

The alkylation process (hydrofluoric and sulfuric acid), are licensed variously by Universal Oil Products Co., Chicago, M. W. Kellogg Co., New York, Phillips Petroleum Co., Bartlesville, Okla. Universal prepared this discussion and flow diagram.



Butane Isomerization

THIS process is one in which normal butane is converted to isobutane under the influence of a catalyst. In many naturally occurring mixtures of butanes, or synthetically prepared cuts of butylenes and butanes, the proportion of normal butane is greater than that of isobutane.

Normal butane in vapor form, at a moderate temperature, is passed through one of several reactors. Each reactor contains a bed of granular catalyst, a constituent of which is aluminum chloride. Dry hydrogen chloride gas is incorporated with the butane vapors to act as a catalyst promotor. After a single pass through the reactors, the stream goes to a receiver through a cooler and refrigerated condenser which liquefies all the butanes, the hydrogen chloride going into solution.

Essential Features of Plant

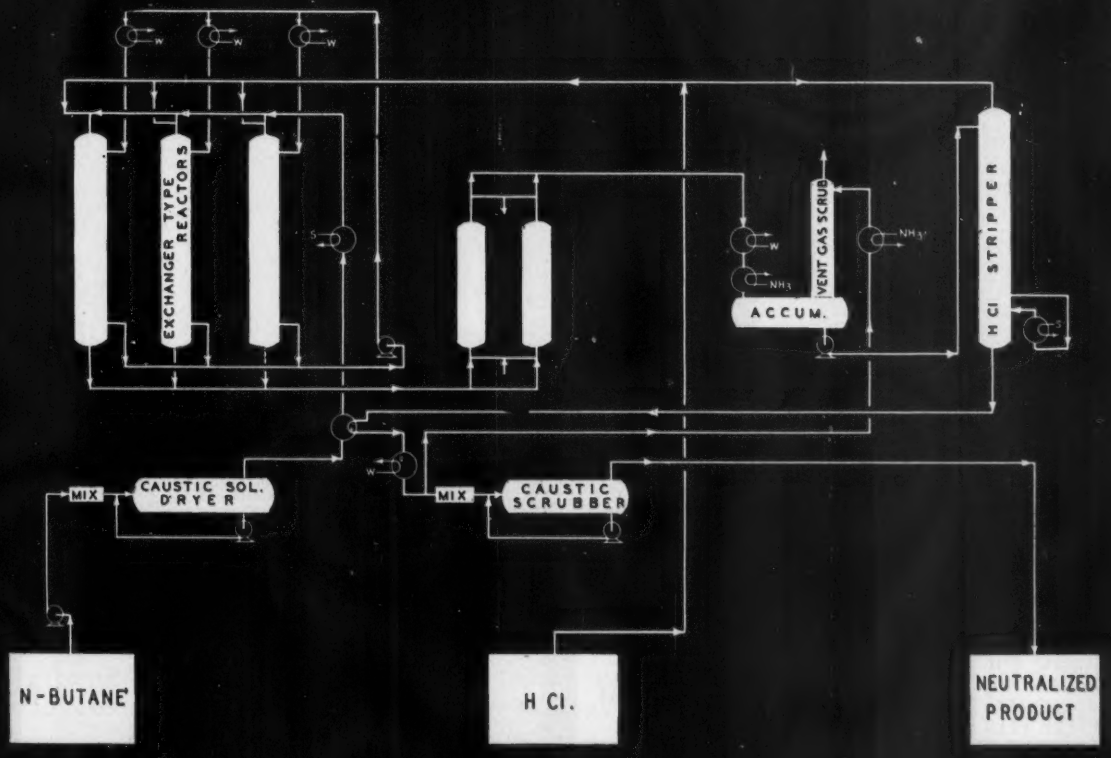
The essential features of a typical isomerization plant are shown in the accompanying flow sheet. The hydrocarbon charge is passed through a drying step which extracts the last trace of moisture. The feed is vaporized and passed through the catalyst beds. Exit streams combine before flowing through condensers and coolers. The condensate is run to a receiver from which it is pumped to the HCl stripping column. Hydrogen chloride separated from the butane is recycled to the reactors. Last traces of hydrogen chloride in the isomerized product are removed by caustic scrubbing.

The catalyst has been specially developed for the purpose. It is rugged, cheaply produced, has long life; these factors make regeneration unnecessary.

Control of the process is mainly by flow-control apparatus. A controller is set in the n-butane charge line; controls may be used on the flow of the catalyst hydrocarbon complex. Temperature in the vent-gas scrubber is regulated by a refrigerant system such as ammonia.

No special construction materials are required for the plant since dry hydrogen chloride, under the prevailing conditions, is not corrosive.

This process is licensed by Shell Development Co., New York.



Isomerization

THE U.O.P. isomerization process is a continuous flow, catalytic process which converts normal paraffin hydrocarbons to their corresponding isomers. This process was developed principally to isomerize normal butane to isobutane for use in the alkylation process. It is also applicable to the isomerization of normal pentane and hexane fractions for octane improvement.

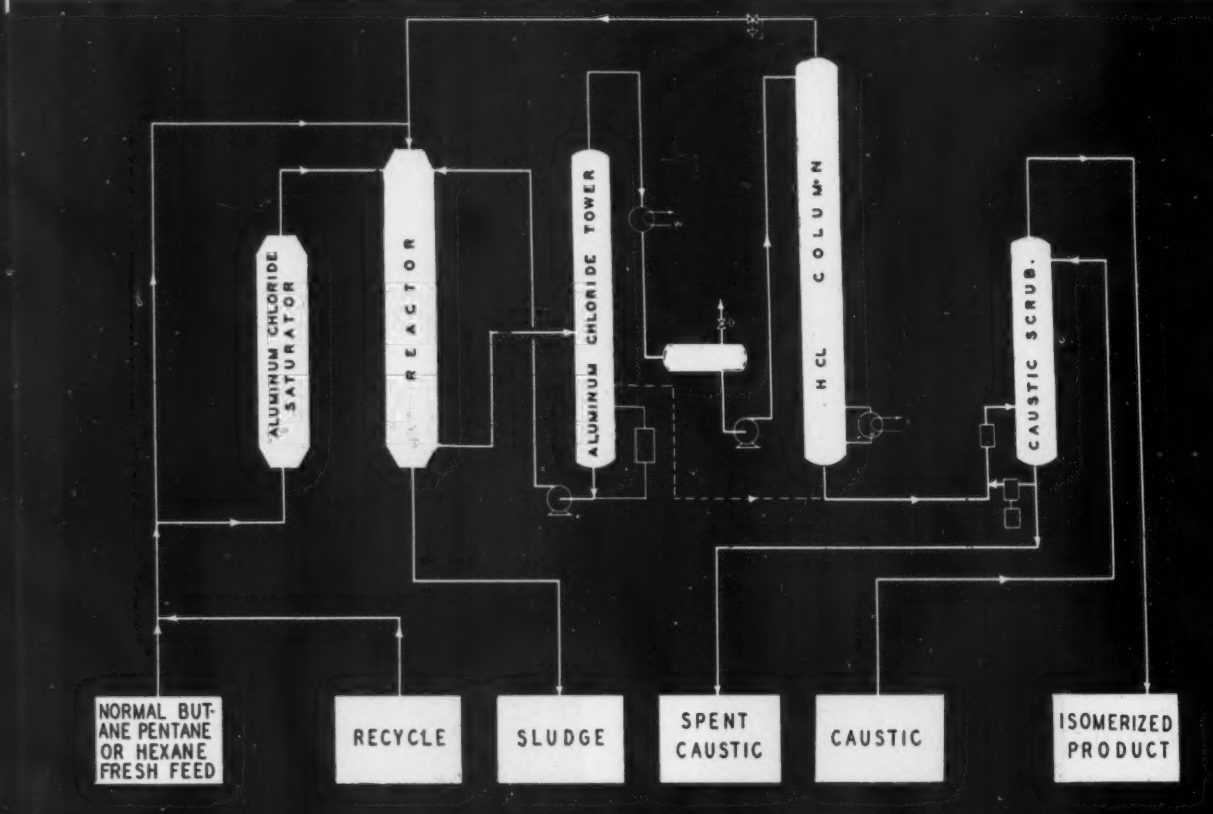
The process essentially is one in which a dry, relatively pure normal paraffin is subjected to the action of a catalyst containing $AlCl_3$ and hydrogen chloride. Isomerization occurs to an extent such that equilibrium between the isomers is approached.

The dry, preheated feed is divided into two streams, dissolving aluminum chloride in one stream to provide continuous addition of this material and using the other for reactor temperature control. These streams plus recycle hydrogen chloride and aluminum chloride enter the reactor at the top and flow downward over the bed of quartz chips upon which the catalyst is deposited. Activity of the catalyst is maintained at the desired level by this continuous addition method while the concentration of the hydrogen chloride, which acts as a promoter, is held at the desired level by the hydrogen chloride recycle. Recycling an aluminum-chloride-bearing stream permits high concentration of aluminum chloride to exist in the reactor without excessive catalyst consumption.

During the isomerization reaction, a minor secondary reaction occurs, i.e., the formation of a viscous liquid sludge containing dissolved aluminum chloride and hydrogen chloride which spreads over the surface of the quartz chips. This sludge drains slowly from the packing and is drawn off intermittently from the bottom of the reactor for neutralization. The hydrocarbon effluent from the reactor is free of sludge but contains some dissolved aluminum chloride and hydrogen chloride. The aluminum chloride is returned to the reactor by recycling of the bottoms stream from the aluminum chloride column. Any pentane and heavier hydrocarbons contained in the feed or formed in the process are removed by drawing a vapor stream from above the reboilers on the aluminum chloride column.

The isomerization of pentanes or hexanes is essentially the same as the butane isomerization process with the exception that in processing these heavier materials the tendency for sludge formation is greater. This is countered by the injection of an inhibitor which suppresses the sludge-forming side reactions.

This process licensed by Universal Oil Products Co., Chicago.



Liquid-Phase Isomerization

THE liquid-phase process differs from the vapor-phase method in that the charge is treated as a liquid and in that the main catalyst, anhydrous aluminum chloride, is handled in solution in molton antimony trichloride.

The raw charge is pumped at essentially atmospheric temperature, through parallel special dryer units, one of which is always undergoing regeneration. Dry hydrogen chloride is added to the dry charge in predetermined small proportions; the temperature is raised in a heater to around 180° F., and charge passes through a packed catalyst-scrubber column.

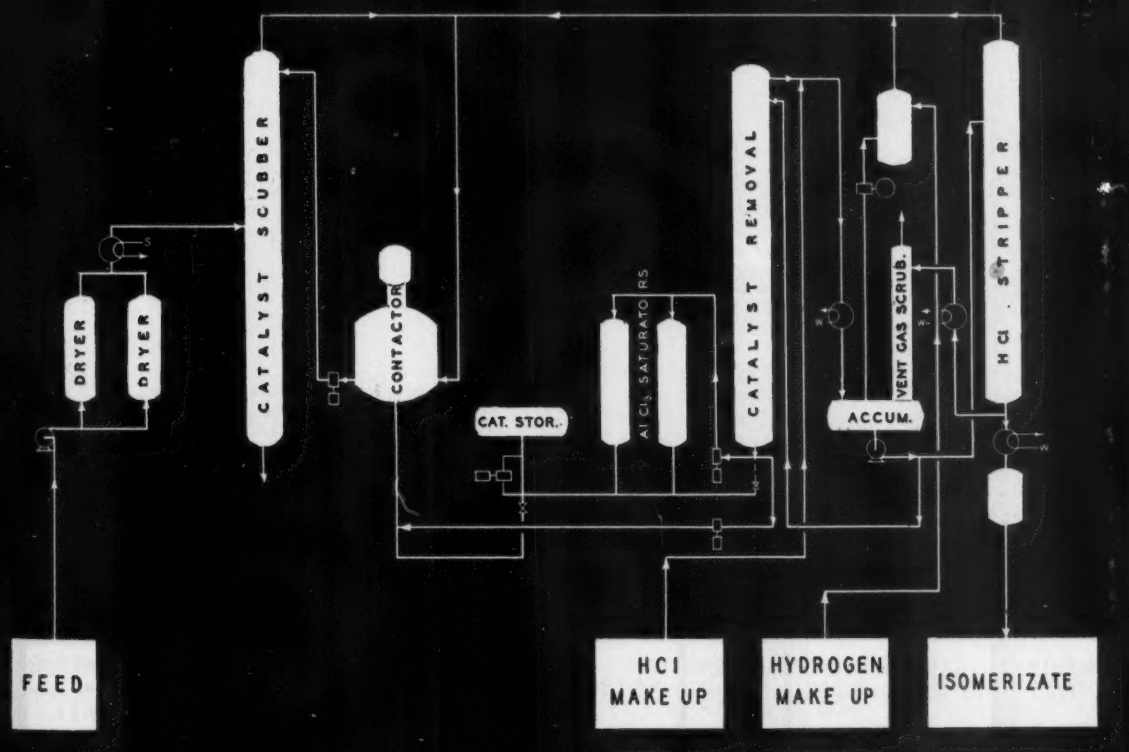
Scrubbed charge enters the contactor which is a vertical autoclave fitted with a mixer to provide intimate contact between charge and catalyst solution. The period of contact is comparatively short, the charge spending 10 to 15 minutes in the contactor (reaction chamber). Charge and product (called isomerizate) are separated from the immiscible catalyst solution in the upper part of the reaction contactor. A 50 per cent conversion is typical for butane and somewhat higher (55-60 per cent) for pentane.

Traces of catalyst are removed from the isomerizate in a fractionator and returned to the reaction contactor. The product is taken overhead in this fractionator, cooled, and sent to the HCl stripper column from which the acid gas is recycled to the reactor feed stock. Bottoms pass to a caustic wash to remove the last traces of HCl, and thence to storage or other plant operations.

When isomerizing pentane, hydrogen gas is compressed and added to the charge stock before it enters the reactor and is recycled from the vapor phase of the catalyst column accumulator. Some hydrogen enters the HCl stripper and is returned to recycle with HCl recovered. Noncondensable gases are also vented from the catalyst column accumulator through a scrubber. Here a returning stream of HCl stripper-column bottoms—isomerizate—absorbs the HCl in the gases and returns them to the stripper for recovery.

The high conversion rate maintained in this process is due to the continuous removal of $AlCl_3$ in the form of its hydrogen complex. Fresh chloride is added by passing a small stream from the bottoms of the catalyst-removal column through a column filled with lump chloride.

This process is licensed by Shell Development Co., New York.



Isomate Process

PRODUCTS from the Indiana isomate process are primarily of interest as blending stocks for high-octane aviation fuels. The process converts low-octane-number pentanes and hexanes into isomers of higher octane number.

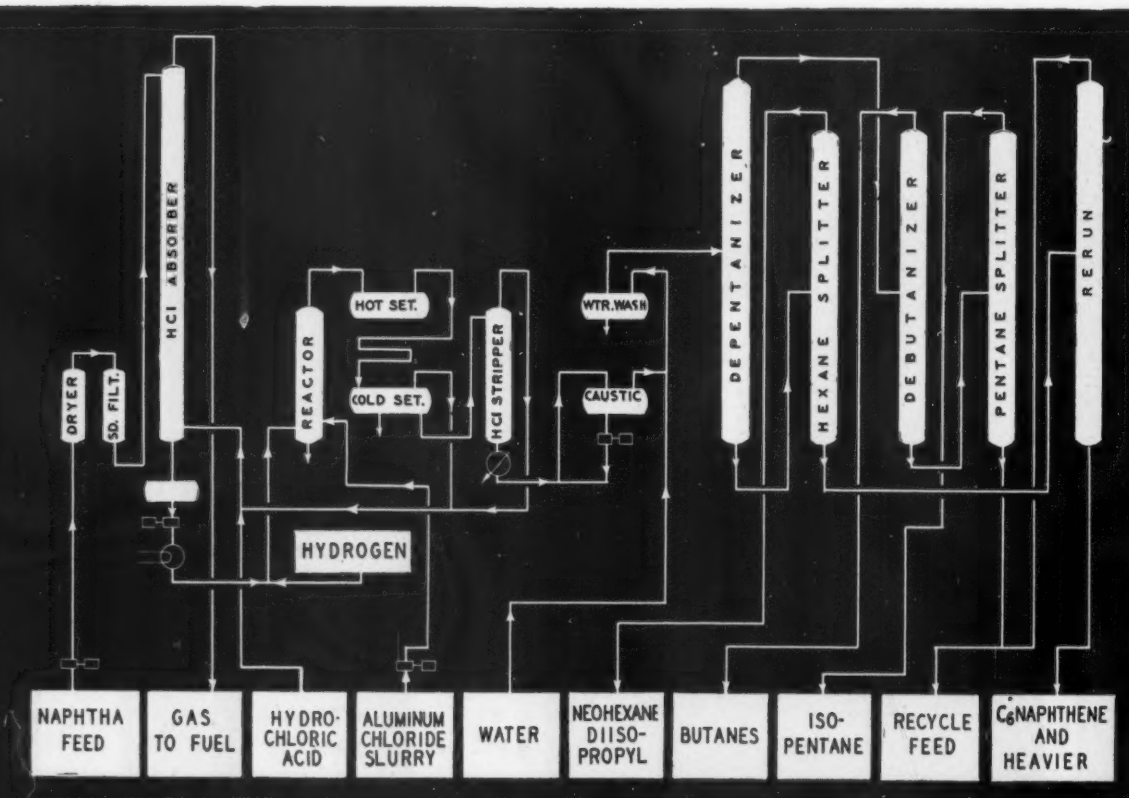
Liquid aluminum chloride-hydrocarbon complex promoted with anhydrous hydrogen chloride is used as a catalyst. Hydrogen is added to repress cracking and disproportionation and to maintain high catalyst activity. Conversion is accomplished by passing the liquid hydrocarbon charge in a dispersed phase upwardly through the catalyst complex. Preferred operating conditions are 240°-250° F. and 700-800 psi. Suitable charging stocks are light, straight-run naphthas containing pentanes and hexanes and but little heavier hydrocarbons.

In addition to handling mixtures of pentanes and hexanes, the process is applicable for the isomerization either of pentanes alone or hexanes alone if the refinery situation indicates such operations to be desirable. However, for the isomerization of pentanes alone, the Indiana pentane isomerization process is somewhat more economical.

A typical operation of the process may be one in which carefully dried 160° F. end-point virgin naphtha is charged to the unit. The stock is treated with a very small percentage of anhydrous hydrochloric acid, brought into contact with a predetermined amount of anhydrous aluminum chloride, and passed into a reactor vessel where the $AlCl_3$ is separated from the reaction product. This product is passed to an aftercooler and the remainder of the catalyst that may be included in the stream is settled out in a drum or other vessel at subatmospheric temperature. The product is run to an HCl stripper, then washed and fractionated into overhead pentanes and hexane bottoms.

When charging a mixture of pentanes and hexanes, the isomate process can be operated on a once-through basis to manufacture a product of 80 unleaded C.F.R-M. octane number. Exceptionally high liquid yields, in the order of 100 volume per cent on charge, can be obtained in this type of operation. By fractionating the once-through isomate and recycling the low-octane-number pentanes and hexanes to the reaction zone, the quality of the product can be raised to 91 unleaded C.F.R.-M. octane number with but a slight sacrifice in yield. When recycling is employed with a charge stock consisting primarily of paraffinic hexanes, the principal product is neohexane.

This process is licensed by Standard Oil Co. (Indiana).



Hydro-forming Process

HYDROFORMING is primarily a catalytic process for converting a low-octane naphtha into a high-octane gasoline. This conversion or reforming is accomplished largely by means of dehydrogenation and cyclization reactions. These reactions are promoted by a molybdena-on-alumina catalyst at 900°-1,000° F. and 150-300 psig., with a high partial pressure of hydrogen in the reaction zone. The hydrogen partial pressure is maintained by recycling hydrogen-rich gas to the reaction zone along with the vaporized fresh feed. The process usually produces a large amount of net hydrogen, which makes possible the hydrogen-rich recycle.

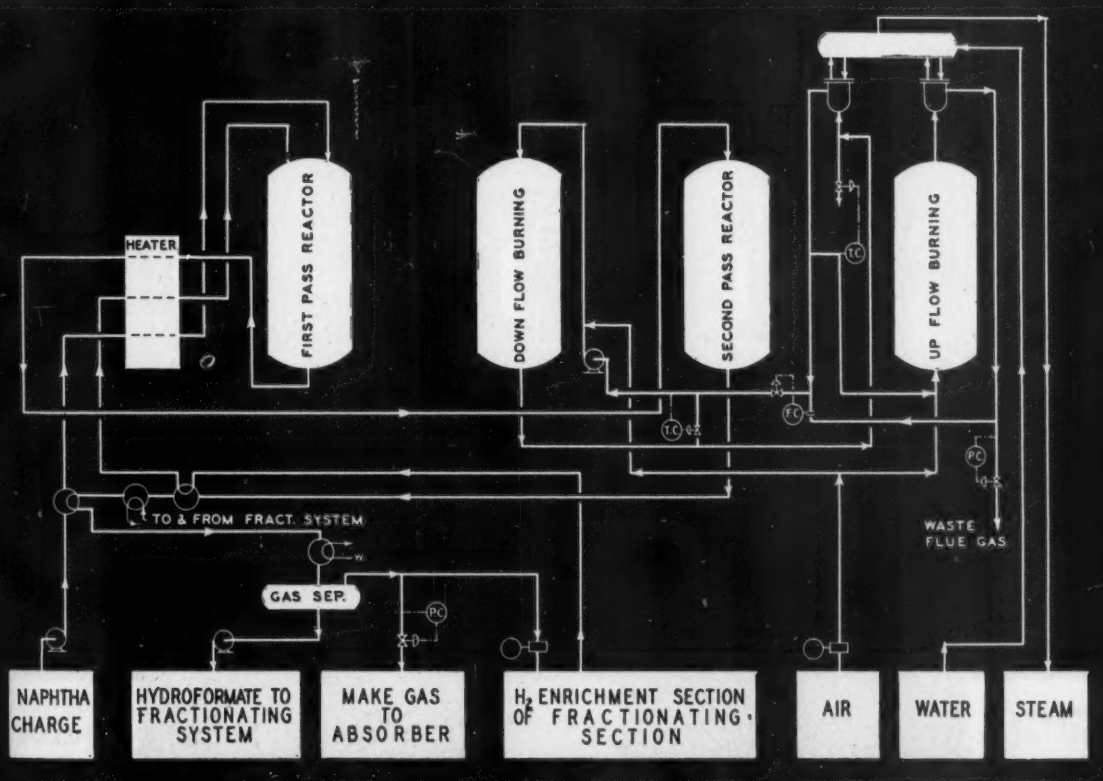
Naphthenes (cycloparaffins) in the feed stock are dehydrogenated and some molecules are slightly rearranged to form aromatics. Considerable cyclization of straight-chain hydrocarbons also takes place. If any olefins are present, as is the case when some cracked naphtha is included in the feed, these are almost completely converted to paraffins or ring compounds. Over 90 per cent of the sulfur contained in the naphtha is removed.

Yields of 78-80 volume per cent of 80 C.F.R.-M. octane, 100 per cent C_4 recovery gasoline are obtained, with the remainder of the material going approximately three-fourths to C_4-free gas and one-fourth to polymer and carbon. When operating to lower octane levels it is possible, by blending in extraneous butanes to the 10-lb. R.v.p. pressure level, to obtain a yield based on feed of 100 per cent of 69-octane gasoline which can be brought up to 80 C.F.R.-M. octane by the addition of 1.5 cc. of TEL.

Hydroforming is carried out in a unit usually having four or more reactors filled with catalyst, half of which are always in series on reaction, and the other half in different stages of regeneration. The reactors are switched from reaction through regeneration and back to reaction in cycles of 8 to 16 hours' duration by an electric cycle controller. Regeneration is necessary because a small deposit of carbon and a partial reduction of the metal in the catalyst combine over a period of hours to reduce the activity of the catalyst. The carbon is burned and the catalyst reoxidized by combustion in a stream of air greatly diluted by cooled and recirculated flue gas.

The reaction products are recovered and fractionated into: (1) a hydrogen-containing gas substantially free of hydrocarbons heavier than propane, (2) a highly aromatic "polymer" boiling above 400° F., and (3) a depropanized, 400° F. end-point gasoline.

The process is licensed by M. W. Kellogg Co., New York, and Universal Oil Products Co., Chicago. Kellogg prepared this discussion and flow diagram.



Thermal Reforming

IN the thermal reforming process the straight-run gasoline or naphtha is charged to a heater where the reforming severity is controlled by the reaction time, pressure, and temperature conditions employed. After pressure reduction, a quench stream from the fractionator is added to the effluent stream to lower the temperature and minimize coking.

This mixture enters a combination flash chamber-fractionator from which a gas and gasoline stream is taken overhead and a residue, amounting to a small per cent of the charge, is removed from the bottom. A side-cut stream is used for quench or heat exchange, or the naphtha side cut may be withdrawn to storage, if desired.

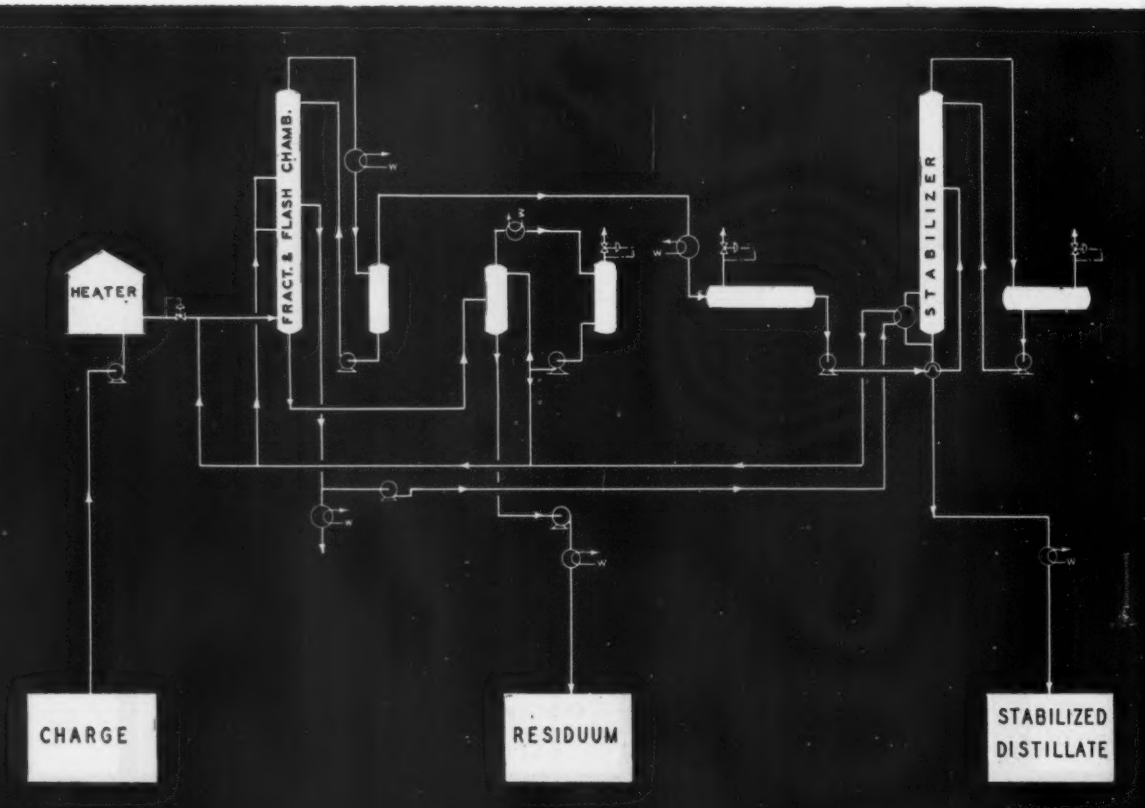
The small quantity of bottoms from the combination flash chamber-fractionator are flashed in a residuum stripper. The lighter material from this stripper is condensed and returned to the fractionating column and the residum is sent to storage for disposal as fuel oil.

A typical result when reforming a 53° A.P.I. Mid-Continent straight-run naphtha is shown in the following tabulation. It must be realized in considering these results that the yields and octane rating improvement that can be derived from thermal reforming are dependent upon the characteristics of the charging stock.

THERMAL REFORMING OF MID-CONTINENT NAPHTHA

Charging stock—	
Gravity, °A.P.I.	53.0
Octane rating, A.S.T.M. (F-2) clear	40.5
Characterization factor	11.96
I.b.p., °F.	208
E.p., °F.	389
Products—	
Gasoline:	
Yield, vol. per cent of charge	81.3
Gravity, °A.P.I.	56.1
R.v.p.-psi.	10.0
I.b.p., °F.	93
E.p., °F.	398
Octane ratings:	
A.S.T.M. (F-2), clear	70.2
+ 3 cc. TEL/gal.	81.9
Research (F-1), clear	78.2
+ 3 cc. TEL/gal.	91.3
Residuum—	
Yield, vol. per cent of charge	4.2
Gravity, °A.P.I.	18.2
Gas—	
Yield, weight per cent of charge	15.3
Cu. ft./bbl. of charge	467

Thermal-reforming processes are licensed by Universal Oil Products Co., Chicago, M. W. Kellogg Co., New York, and others. Universal prepared this discussion and flow diagram.



Vis-breaking

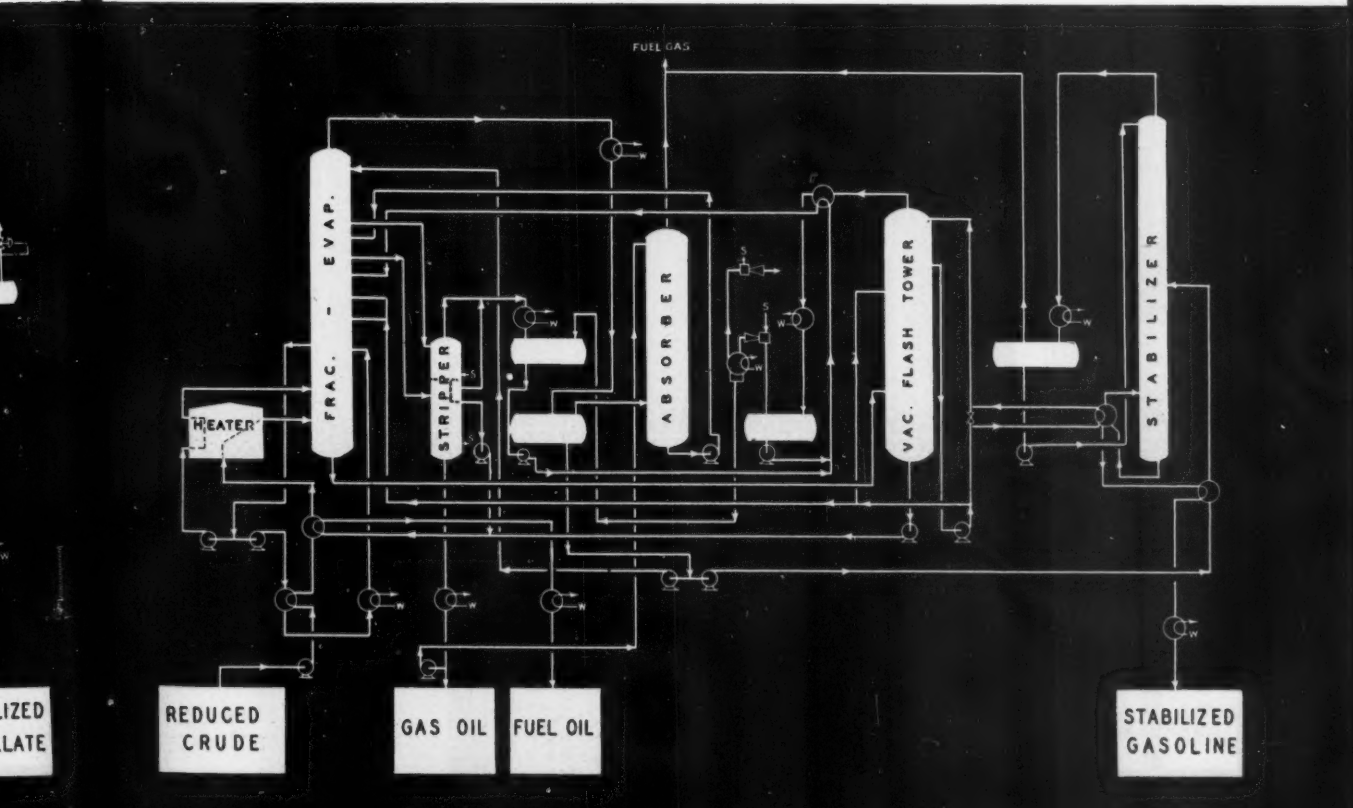
THE process called viscosity breaking has a wide application in the refinery and is employed especially where a large amount of heavy residual crude is made, and where a minimum of residual fuel oil is wanted, with a maximum yield of low pour point, low-viscosity cracked gas oil is desirable. The process converts heavy residuals to the more profitable distillates of higher gravity and lower viscosity.

The process usually takes topped crude of either paraffinic, asphaltic, or mixed base and removes a small amount of gas oil at atmospheric pressure in a separate tower; the reduced crude then is subjected to higher temperature and pressure, and is distilled under mild cracking conditions to vaporize large proportions of the viscous charge as cracked gas oil of much lower viscosity, hence the term "vis.-breaking." These operating conditions may vary greatly, depending on the results wanted and on the nature of the charge stock; temperature of 885° F., pressure of 300 psig., are typical of fairly heavy charge stocks. With the partial cracking of the heavy oil small amounts of light material of gasoline boiling range is formed and vaporized with the cracked gas oil. On one heavy California charge yields of 16 per cent of 69-octane-number gasoline, 14 per cent of straightrun gas oil, 19 per cent of 25 pour cracked gas oil, and about 51 per cent of heavy fuel oil has been obtained. Omitting the straightrun gas oil, typical yields of three products are: gasoline, up to 20 per cent; cracked gas oil, 25 per cent; heavy fuel oil (125 seconds Saybolt Furol viscosity at 122° F.), 55 per cent. Pour points and viscosities of the two fuel oils may be reduced by using more severe conditions with some loss in yields.

Viscosity-breaking units are frequently operated in conjunction with recycle cracking; the vis breaker is generally fitted to operate in series with a cracking coil as a thermal cracking unit if occasion requires, either to make liquid residual fuel or to run to coke without any heavy fuel oil. Properties of products made are typified by the following:

Inspection—	Straight-run gas oil	Cracked gas oil	Stabilized gasoline	Fuel Oil
Gravity, °A.P.I.	14.2	25.1	63.4	9.8
Init. b.p., °F.	62	448	90	...
50 per cent, °F.	564	608	234	...
Final b.p., °F.	730	696	350	...
Pour point, °F.	35	25	...	20
Flash, p.m., °F.	156	230	...	158
Viscosity, S.S.U. at 100° F.	54	51	...	(122) 125
Octane number, M.M.	...	...	69.0	...
R.v.p., psi.	...	...	9.9	...

Diagram and data on which the discussion is based were supplied by The Lummus Co.



Thermal Cracking

BASIC equipment in two-coil U.O.P. thermal cracking includes a light-oil heater, a heavy-oil heater, a reaction chamber, a flash chamber, and a fractionating column. The topped or reduced crude to be cracked is pumped through heat exchangers into the fractionating column where it contacts with hot vapors from the flash chamber. This direct exchange of heat vaporizes the light portion of the charging stock and condenses the heavy hydrocarbons in the flash-chamber vapors. The light gases and gasoline are removed overhead. The light oil is removed as a side cut for pumping to the light-oil coil and the heavy oil is removed from the bottom for processing in the heavy-oil coil.

The hydrocarbons from the two furnaces are combined in the reaction chamber where additional cracking occurs. The downward-flowing hydrocarbons are drawn off the bottom through a pressure-control valve, are quenched, and directed to a flash chamber. The heavy hydrocarbons drawn from the bottom of the flash chamber are given a secondary low-pressure flash from which residuum is drawn off as a high-grade heavy fuel oil. The flash-chamber vapors contain the gasoline and lighter products from cracking as well as light and heavy-oil components which are recycled to the heaters along with the fresh feed.

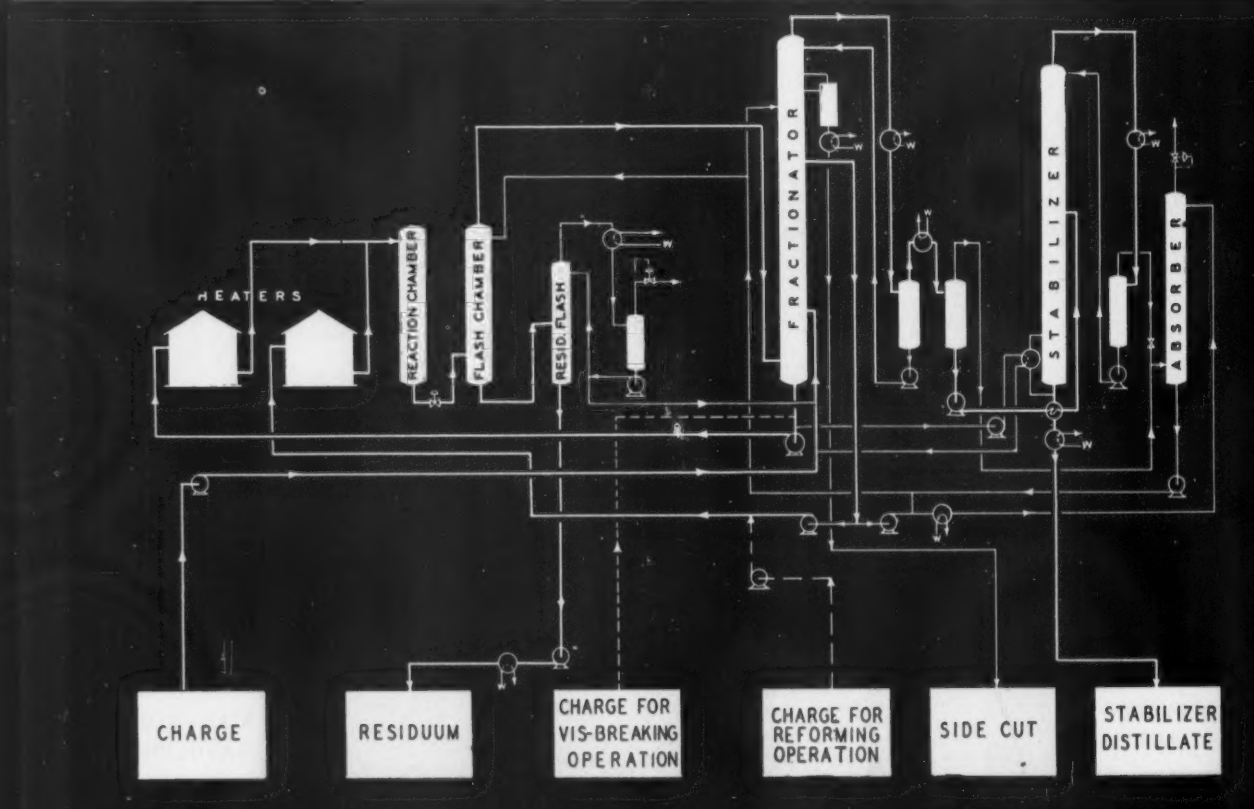
Purpose of the reaction chamber is to increase the time-temperature relationship over that which can be obtained using only a heater, thus improving the gasoline yield at the same viscosity fuel oil. High reaction-chamber temperatures are desirable when cracking heavy residual stocks because of the high cracking rate which reduces plant costs.

Single-Coil Unit

The single-coil thermal cracking unit is similar to the two-coil unit with the exception that the recycle and fresh charge are cracked all together in one heater.

Representative of the result obtained in two of the various methods of processing a typical 25°-A.P.I. Mid-Continent reduced crude having a viscosity of 20 S.F.S. at 122° F. are: When operating to produce maximum gasoline (53.5 per cent) fuel-oil yields are 37.5 per cent and no furnace distillate is obtained. Producing maximum furnace oil (23 per cent) gasoline yield falls to 38 per cent. Viscosity and gravity of charge stocks are important in determining yields.

Thermal cracking processes are licensed variously by Universal Oil Products Co., Chicago, M. W. Kellogg Co., New York, and other licensors. Universal prepared this discussion and flow diagram.



Catalytic Desulfurization

THE Perco catalytic desulfurization process removes, in general, 40 to 60 per cent of the sulfur content of cracked gasolines, 60 to 98 per cent from straight-run gasolines, and 90 to 100 per cent from natural gasolines. Sulfur compounds removed include mercaptans, sulfides, and disulfides, while the cyclic compounds are not greatly affected. The variation in quantity of cyclic compounds present in the foregoing gasoline accounts for the differences in reduction of total sulfur content.

The feed is usually vaporized by heat exchange with the product leaving the catalyst tower, and then superheated to about 750° F. The superheated vapors are passed through the catalyst bed (50 psi. or less), where organic sulfur compounds are decomposed to hydrogen sulfide. The flow rate may range from 100 to 300 bbl. of liquid feed stock per ton of catalyst per day. After cooling and condensing the product, the hydrogen sulfide is removed by fractionation or chemical treatment or both.

Operating cycles up to 30 days or more for a charge of catalyst are obtained on many gasolines. Catalyst cost is in the order of 1 cent per barrel of gasoline treated.

The treatment of cracked gasolines or blends containing cracked gasolines tends to deactivate the catalyst. Auxiliary equipment is provided for catalyst regeneration, which is accomplished by charging to the alternate chamber a stream of low-pressure air to burn off the carbonaceous matter.

This process is licensed by Phillips Petroleum Co., Bartlesville, Okla.

CRACKED GASOLINE

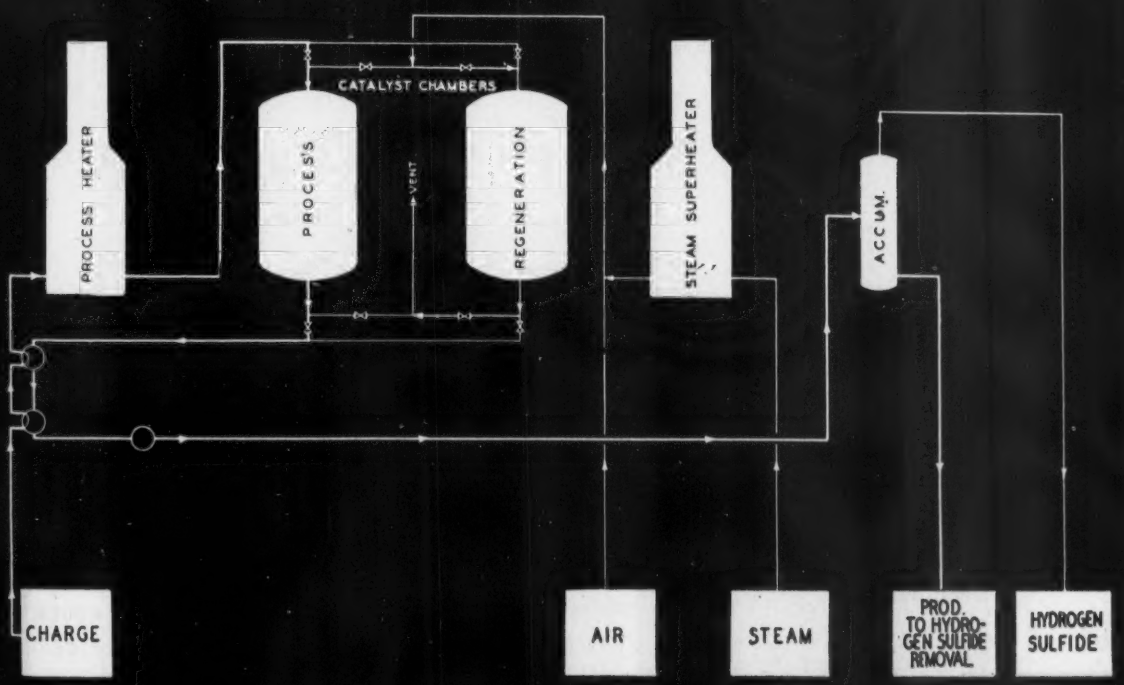
56° A.P.I. gravity; 9-lb. R.v.p.; 420° F. end point

	Undesulfurized	Desulfurized
A.S.T.M. octane number	65.7	69.1
+ 1 cc. TEL	70.0	75.8
+ 2 cc. TEL	72.4	78.0
+ 3 cc. TEL	74.5	79.8
Total sulfur, per cent	0.140	0.076
Mercaptan sulfur, per cent	0.062	0.003

STRAIGHTRUN GASOLINE

58° A.P.I. gravity; 6-lb. R.v.p.; 440° F. end point

	Undesulfurized	Desulfurized
A.S.T.M. octane number	53.8	57.8
+ 1 cc. TEL	59.2	68.9
+ 2 cc. TEL	63.0	74.1
+ 3 cc. TEL	65.9	77.4
Total sulfur, per cent	0.309	0.017
Mercaptan sulfur, per cent	0.148	0.000



Phosphate Desulfurization

THE phosphate process developed by Shell is a regenerative liquid purification system for the removal and recovery of hydrogen sulfide from gaseous and liquid hydrocarbons. The principle absorption reaction is expressed

$$H_2S + K_2PO_4 \rightarrow KHS + K_2HPO_4$$

Regeneration reverses this action.

The inexpensive solution used originally is prepared at the plant from commercial grades of potassium hydroxide and phosphoric acid in such proportion that the nolal ratio of KOH to H_3PO_4 is between 2.95 and 3.00 to 1. Optimum concentration of K_2PO_4 depends upon the amount and nature of impurities in the hydrocarbon processed. K_2PO_4 does not contaminate nor polymerize the hydrocarbon.

In the accompanying flow diagram the sour feed is scrubbed in a countercurrent absorber of bubble-plate or packed-tower construction. The hydrogen sulfide content of the feed can be reduced low enough to satisfy any reasonable refinery requirement.

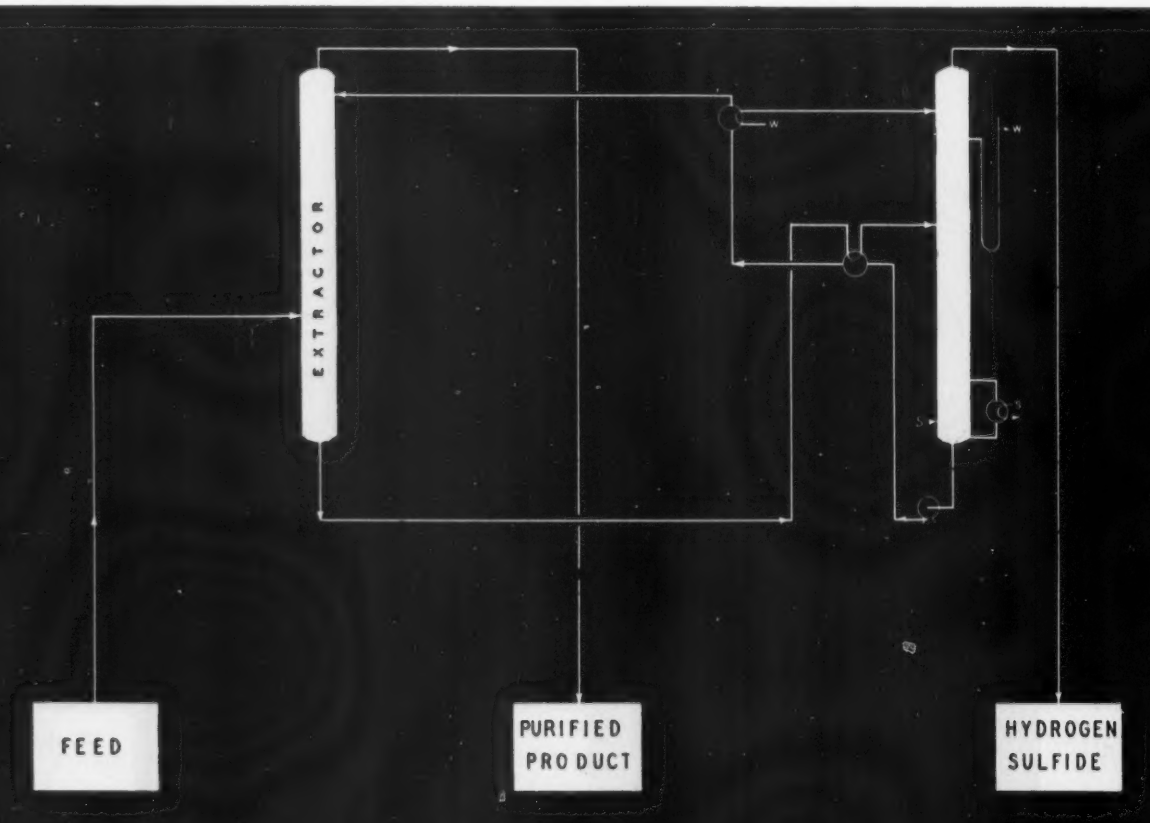
Regeneration of the spent solution is accomplished by heating the solution to its boiling point and stripping with steam in a bubble-plate column. Alternately, exhaust steam at low pressure may be directed into the bottom of the stripper column.

Operating and maintenance costs are low. Full automatic control is possible, so that only part of an operator's time is required for general supervision. Occasional analyses indicate proper operation.

Control items are few and simple. Flow controls on raw feed inlet, or extract solution inlet, and on steam to the regenerator to control temperature are required. If a solution concentrator is used the steam or hot oil or other heating medium must be controlled, generally at temperatures which will give the required concentration, as found by experience.

Iron and steel are satisfactory for all equipment. In case of corrosive cooling water, admiralty-metal tubes and Muntz-metal sheets and baffles may be used for condenser and solution cooler. Gages, instruments, valves, and pumps should be all iron and steel. Monel or stainless-steel trim can be used.

The process is licensed by Shell Development Co., New York.



Copper Sweetening

THESE processes take advantage of the oxidation of mercaptans by cupric chloride, and the subsequent regeneration of the cuprous chloride with oxygen (air):

$$\underset{\text{(Mercaptan)}}{2\,RSH} + \underset{\text{(Cupric chloride)}}{2CuCl_2} \rightarrow \underset{\text{(Disulfide)}}{RSSR} + \underset{\text{(Cuprous chloride)}}{2CuCl} + \underset{\text{(Hydrochloric acid)}}{2HCl} \quad (1)$$

$$2\,CuCl + 2\,HCl + 1/2\,O_2 \rightarrow 2\,CuCl_2 + H_2O \quad (2)$$

$$2\,RSH + 1/2\,O_2 \rightarrow RSSR + H_2O \quad (3) + (2)$$

The Perco processes are applicable to any stock requiring sweetening and are especially suitable for those of a very sour nature since these are handled with only a slightly higher cost due to increased air requirements. This method of sweetening is applied in two ways.

Solid process.—If the stock to be treated is sufficiently stable in color and gum when treated in presence of air, it is mixed with the necessary air and percolated through a bed of absorbent material impregnated with the copper reagent.

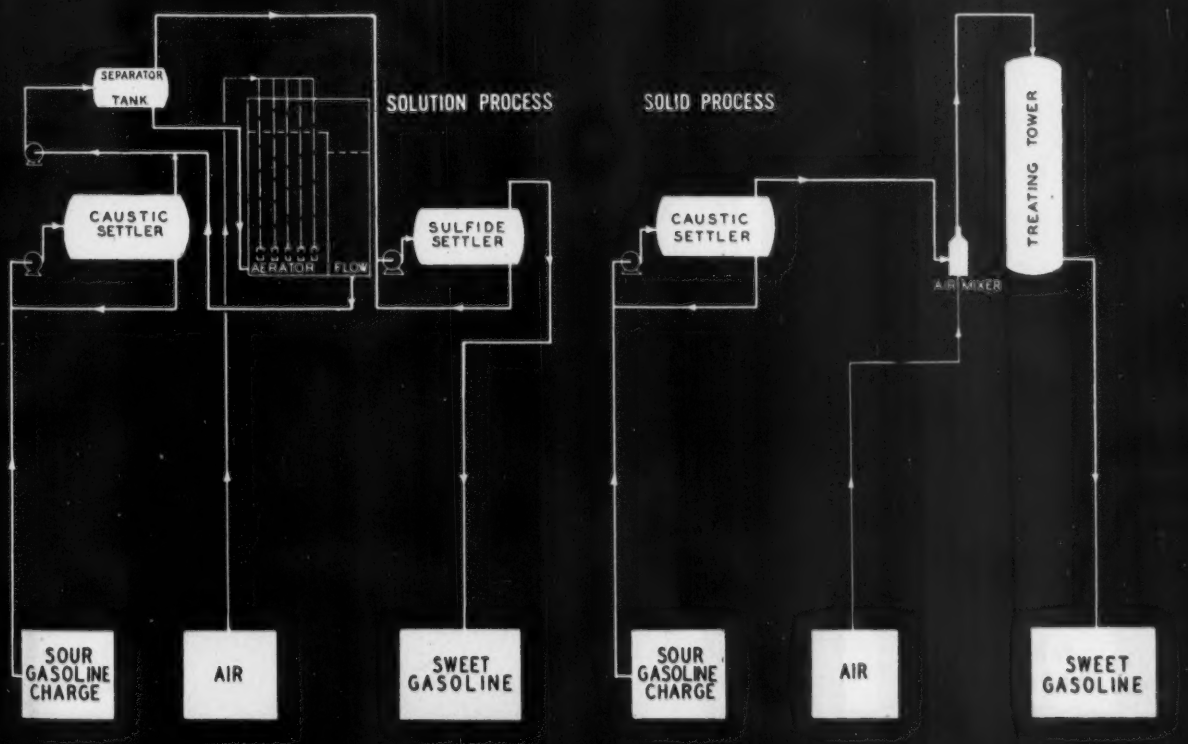
Solution process.—Other stocks are continuously treated with the copper solution in the absence of air and the copper regenerated in a separate tank. The oxidizing power of the solution is controlled to prevent side reactions with unstable hydrocarbon constituents. Stocks treated with the copper solution are given a final sodium sulfide wash to give color and gum stability, by removing minute traces of copper which may be present in the treated oil.

In either process, if the gasoline to be sweetened contains hydrogen sulfide, this component is removed by a caustic-washing step prior to the sweetening operations. Likewise, if free sulfur is present in the stock, this compound is removed by a caustic-polysulfide treatment prior to the sweetening operations.

The following example of liquid treatment of a cracked distillate having a 170°-400° F. boiling range and 53° A.P.I. gravity is typical of results obtained in comparison to doctor treating.

	Sour	Doctor treated	Perco treated
Color, Saybolt	+2	−5	+2
Octane number:			
Without lead	62.9	61.9	62.9
+ 1 cc. TEL	68.5	67.8	68.5
+ 2 cc. TEL	71.7	71.0	71.7
Induction period, min.:			
Without inhibitor	130	130	180
With 0.002 per cent inhibitor	320	190	415
With 0.004 per cent inhibitor	485	305	640
A.S.T.M. gum	2.6	0.4	0.0

This process is licensed by Phillips Petroleum Co., Bartlesville, Okla.



Mercapsol Process

THE Mercapsol gasoline-treating process removes mercaptans from gasoline by extraction with aqueous caustic soda fortified with certain solubility promoters. Extraction of mercaptans is ordinarily carried out countercurrently in a conventional packed tower, but existing multistage mixing and settling equipment can also be adapted to the process. The extracted mercaptans are removed from the Mercapsol solution by steam stripping in a bubble plate tower or a packed tower.

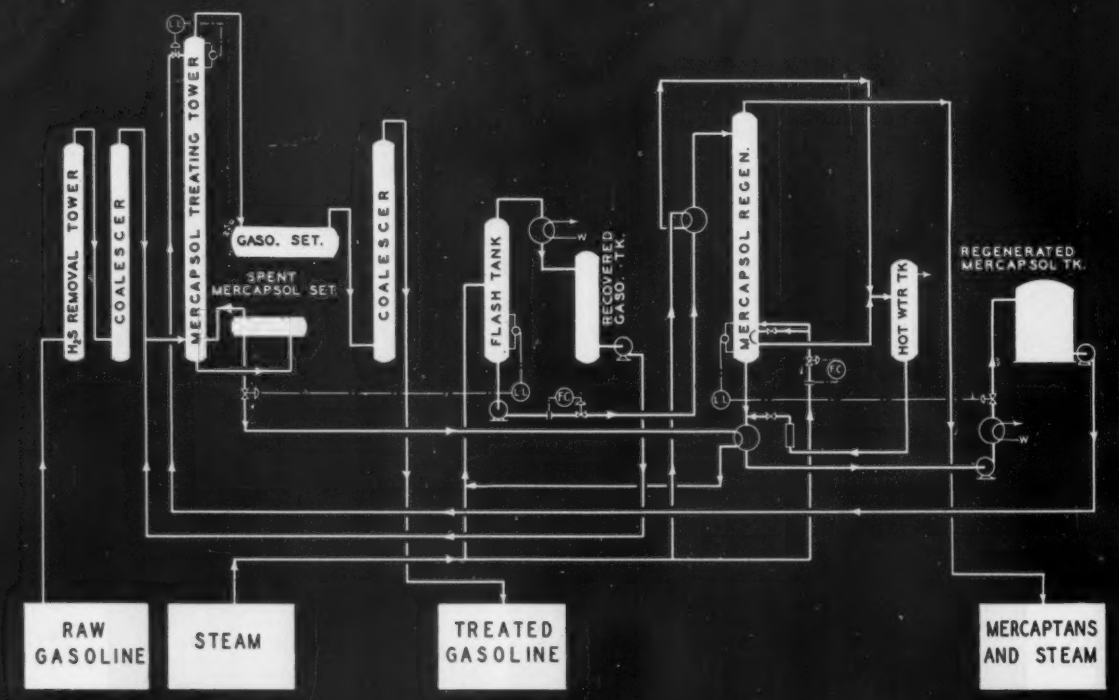
Removal of mercaptans by the Mercapsol process results in a decrease of total sulfur in the gasoline, thereby providing substantial savings of tetraethyl lead. The process produces treated gasoline which is "doctor sweet" in many cases or of such low mercaptan concentration, in almost any case, that the effect of the remaining mercaptan on odor or lead susceptibility is not detectable.

The process is tailored to each refiner's requirements, and the ultimate design is governed by his specifications for finished gasoline and the properties of the raw gasoline to be treated. Existing equipment is fully utilized, and such factors as cost and availability of utilities such as steam and cooling water are taken into account. By suitable instrumentation the operation of the process can be made practically automatic so that only a minimum amount of attention is required.

Raw gasoline enters the H_2S removal tower near the bottom and flows upward through a column of approximately 5 per cent caustic soda. From the top of the H_2S removal tower the gasoline passes upward through a packed coalescer whose function is to remove aqueous phase and anything contained therein from the gasoline. The gasoline then enters the mercaptan removal tower near the bottom and flows through the packing countercurrently to the downcoming stream of Mercapsol solution, which extracts substantially all of the mercaptans from the gasoline. The gasoline then goes to a settler and from there upward through a coalescer to remove and recover the last traces of treating solution before going to storage.

Steam condensate is collected in a small tank and, since this water is free of dissolved solids, and is used to replace the small amount of water evaporated from the Mercapsol during regeneration. The Mercapsol solution lasts indefinitely and requires only a very small amount of makeup because of pumping and other minor losses.

The Mercapsol process is licensed by Pure Oil Co., Chicago.



Lead Sulfide Sweetening

THIS process employs sulfur as the reactant in sweetening sour gasoline with lead sulfide (PbS) as the agent. Involving sulfur instead of oxygen in the reaction hydrogen sulfide rather than water is found.

The main reaction in the process is:

$$4RSH + S_2 \xrightarrow{PbS\ (cat.)} R_2S_2 + H_2S$$

Mercaptan — Disulfide — Hydrogen sulfide

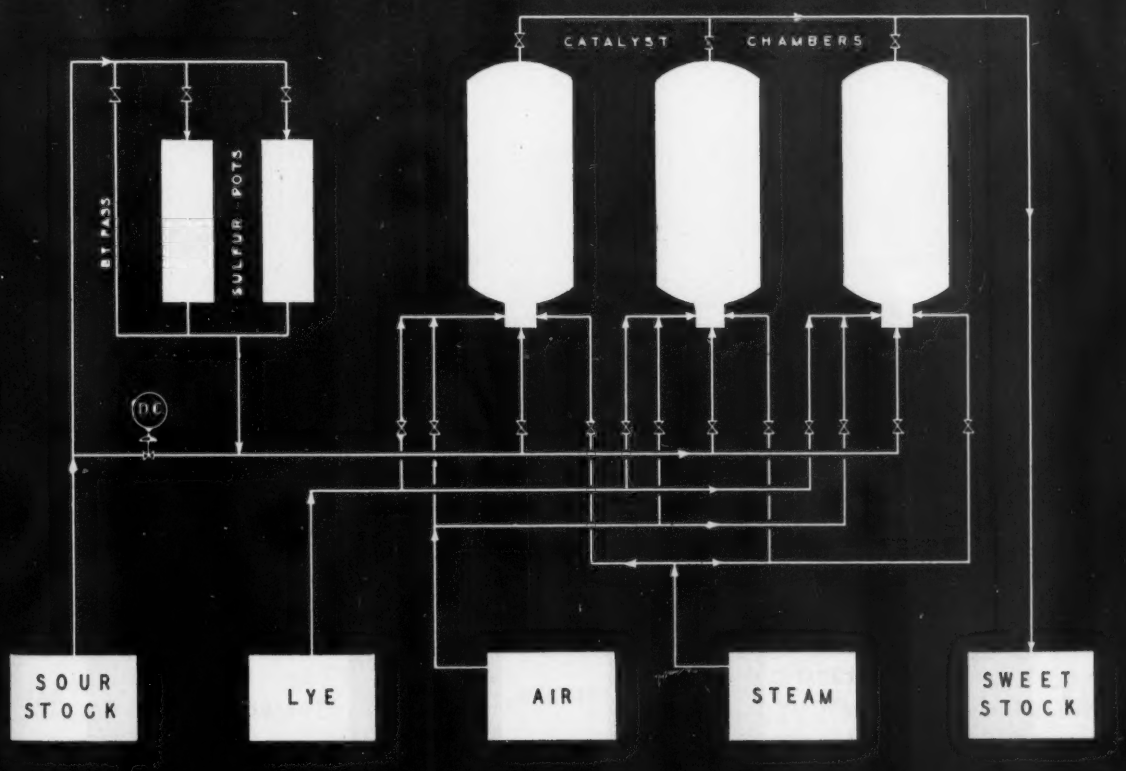
Caustic soda added to the mixture to react with the sulfide permits continuance of the reaction. Admission of oxygen must be held to a minimum, it is claimed. Oxygen damages the PbS catalyst, converting it probably during the sweetening process to $PbSO_4$, lead sulfate, which is converted to the sulfide again only with great difficulty and has very little sweetening reactivity. The principal (sulfur) reaction is also interfered with by the presence of oxygen.

Problems in adapting this reaction to refinery sweetening operations are probably those of catalyst preparation and control of the sulfur and alkali solutions. Catalyst is prepared by coating carrier-pellet surfaces with a lead compound which is converted to the sulfide after the catalyst material is in place, ready for use. Pellet size and catalyst-bed proportions are important in obtaining the optimum results in treating any stock.

Raw stock entering the system is divided into two streams, part of which passes through sulfur pots where it picks up sufficient sulfur to carry out the primary reaction. The remainder of the stock flows to the catalyst towers where it mingles with the caustic, air, and/or steam injected into the tower base. Air or steam aids in mixing caustic and charge stock. The solution and charge enter at the bottom and travel up the towers where sulfur content of the reaction mixture is controlled by the amount of charge sent through the pots, to a predetermined range of concentration.

The reaction proceeds best, and with little operator attention after the concentrations are determined, by removing a maximum amount of the introduced caustic with live steam; air is not used until the normal action of the catalyst bed has decreased due to physical causes and should then be used sparingly since the tendency to convert the sulfide to sulfate is strong.

This process was developed by Sinclair Refining Co. technologists.



$CuCl_2$-Oxygen Treating

DEVELOPED by Linde Air Products Co., this process is applicable to complete sweetening of all types of gasolines, kerosines, special solvents, and distillates. The organic mercaptans are converted to disulfides by chemical reaction between organic mercaptans, copper chloride, and oxygen.

First step is the complete removal of hydrogen sulfide by contacting the hydrocarbon stock with caustic soda solution in conventional equipment. The sour stock is then passed through a salt filter to remove all suspended water, heated to dissolve and continuously remove from the treating tank water formed in the sweetening reaction. This water of reaction is directly proportional to the mercaptan content and is readily removed by utilizing the increase in solubility of water in hydrocarbons with increased temperatures. A temperature increase of 5° to 25° F. is usually sufficient for the average stock.

From the heater flow is to the slurry mixing eductor. Approximately 10 per cent of the total sour stock flows through another eductor located in a by-pass line. Pure oxygen for regeneration of the copper chloride is continuously added to this bypassed portion of the stock. The oxygen required is small—approximately 0.10 cu. ft. per barrel for each 0.01 per cent of mercaptan sulfur.

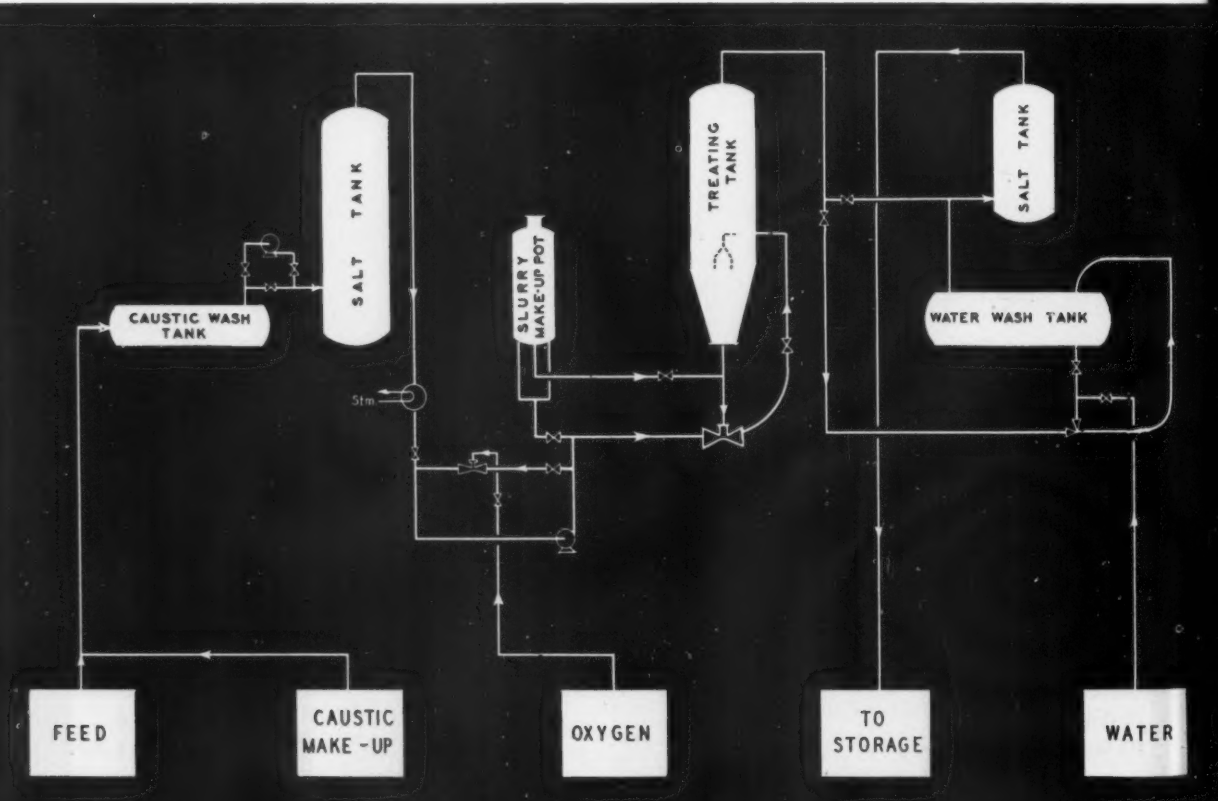
A mixture of 200-mesh clay and 40-60-mesh copper chloride is added to the slurry makeup pot and hydrocarbon stock from the centrifugal pump is introduced to pressurize the pot. This mixture of clay, copper chloride, and hydrocarbons is forced under pressure into the cone-bottom treating tank.

Total throughput of stock containing the dissolved oxygen is discharged into the eductor. The copper chloride, clay, and hydrocarbons flow as a slurry from bottom of the treating tank into the eductor.

The mixture of slurry and sweetened stock flows through a return line at reduced pressure into the reactor vessel. Here the copper chloride-clay mixture is given initial velocity. It settles into the conical bottom and is recirculated. The sweet stock flows upward and is discharged from the top.

The stock flows from the treating tank through a mixing device where it is contacted with water. The water-stock mixture discharges into a settling tank and the water is settled out and recirculated. If the products being sweetened are straight-run stocks, no further treatment is required. In the case of cracked gasolines, kerosines, and distillates, a small amount of metal deactivator is added to counteract possible detrimental effect of dissolved copper compounds.

This process is licensed by Linde Air Products Co., New York.



Tannin Solutizer

PRODUCT improvement, increase in octane number and lead susceptibility are obtained by this process. Heart of the method is sulfur reduction which involves two steps. A tannin-catalyzed oxidation regeneration step follows a mercaptan-extraction operation which employs strong caustic solutions. The latter contain mercaptan solubility promoters termed "solutizers," such as isobutyric acid and/or alkyl phenols.

The tannin solutizer process, as illustrated in the flow diagram, consists essentially of the caustic pretreat, the solutizer treatment, and the regeneration system. Caustic pretreatment is usually required for removal of strongly acidic components, such as hydrogen sulfide, and in some cases for control of alkyl phenol concentration.

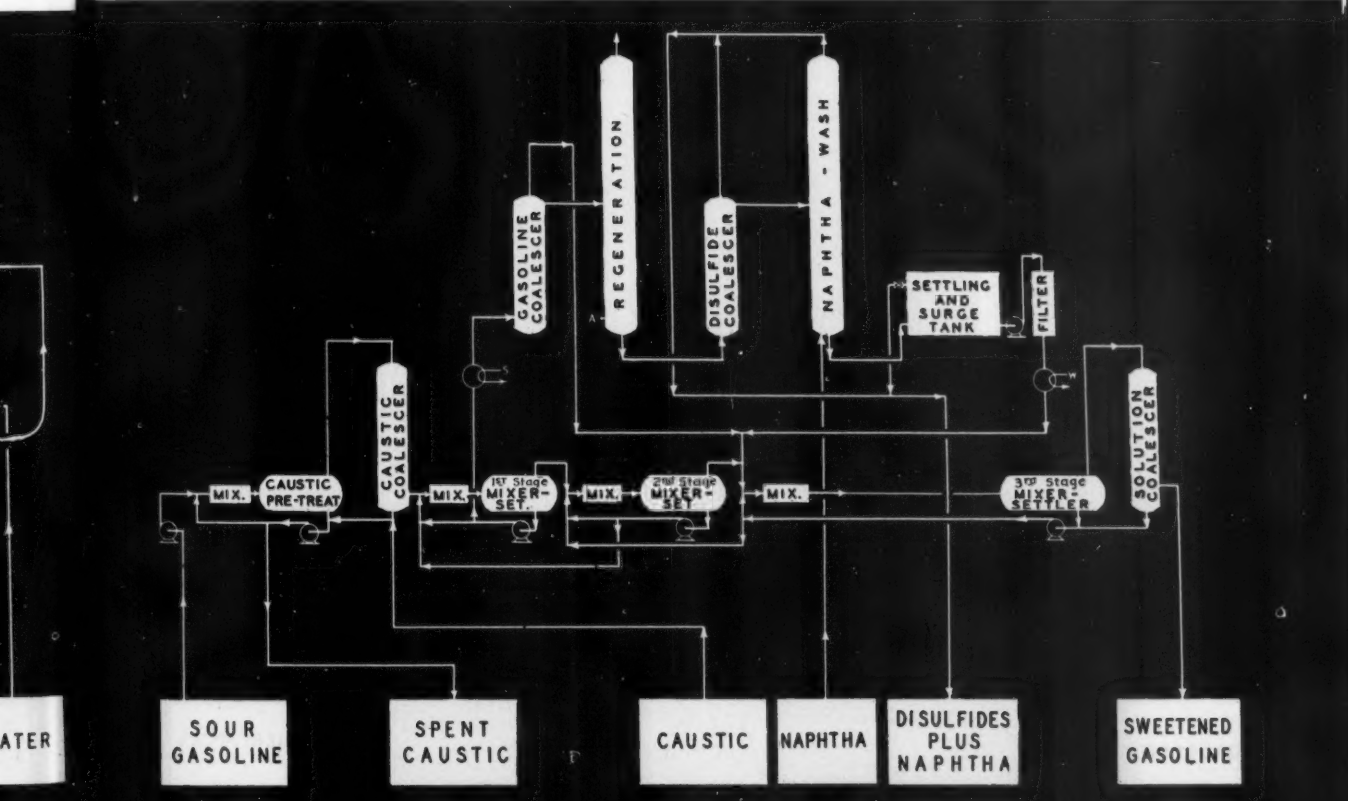
The sour hydrocarbon feed after pretreatment enters the extraction system in which it is countercurrently contacted with the solutizer solution. This solution may contain added isobutyric acid solutizer, or naturally occurring alkyl phenols.

Treating solution from the extraction step is preheated to a temperature of 110° to 130° F., and flows to the regeneration column in which the extracted mercaptans are catalytically oxidized by air blowing to the corresponding disulfides. This operation may be accomplished in a column equipped with efficient air dispersers or in any standard liquid-gas mixing device. The regenerated solution is coalesced for removal of entrained disulfide oil and the portion of this material remaining in solution is removed by a simple countercurrent or batch naphtha wash step.

Control in the process is chiefly flow control; flow regulators determine the ratio or proportions of treating agent and naphtha to be treated, the rate of flow from mixer to settler to mixer, etc. Temperature of the spent solution to the regenerator is controlled by exhaust or other steam by throttling the steam to give the desired temperature.

This process easily achieves mercaptan removal to the 0.001 to 0.003 per cent weight mercaptan sulfur level when treating a wide range of straightrun or cracked stocks, either low-end-point or full-boiling-range gasolines, having a naphthenic or paraffinic crude source. Mercaptan reduction to the doctor negative specification may be obtained in many cases.

This process is licensed by Shell Development Co., New York, under its patent and those of Socony-Vacuum Oil Co., Inc.



Unisol Process

EXTRACTION of mercaptans by means of the Unisol process is based primarily on the large increase in the solubility of mercaptans in caustic soda solutions when an organic solvent, methyl alcohol, is present. The hydrogen-sulfide-free gasoline enters the mercaptan scrubbing column at the bottom and is purified of mercaptan-sulfur compounds as it passes up the column countercurrent to an aqueous caustic soda and methanol solution. The concentrated methanol solution enters the extraction column at the midpoint and the regenerated caustic solution enters at the top.

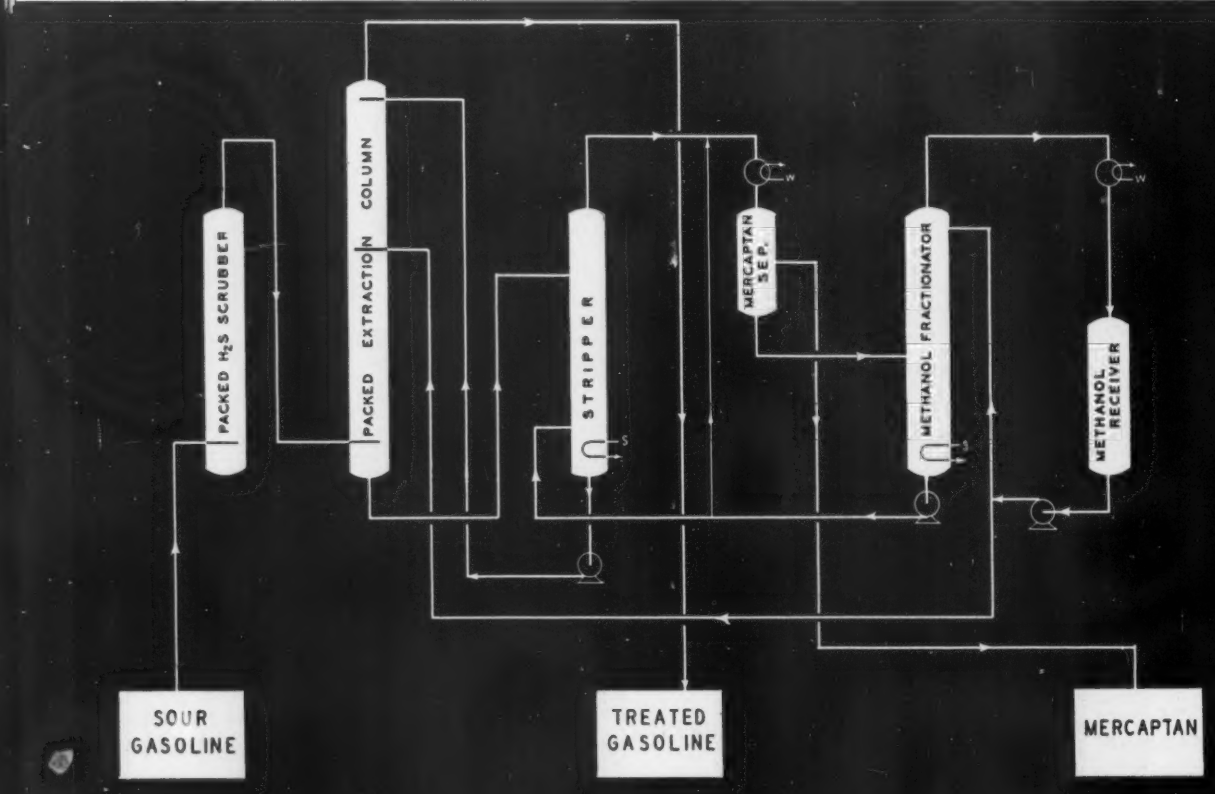
The mercaptan extraction is performed principally in the section of the column below the methanol inlet point. The caustic entering the top of the column removes dissolved methanol from the gasoline stream and flows downward to combine with the major portion of the methanol stream to perform the extraction. The treated gasoline flows from the top of the extractor without additional treatment except the addition of inhibitor.

Methanol Recovered

The methanol-caustic soda solution containing dissolved mercaptans flows out of the bottom of the extraction column and is charged to the regenerator where methanol and mercaptan are stripped from the caustic solution which is then returned to the extractor. Overhead from the regenerator consisting of steam, methanol, and mercaptan vapors, is condensed. Liquid in the receiver separates into two phases, a concentrated mercaptan phase and a methanol phase, thus permitting the mercaptan to be decanted from the system. The methanol-water solution is charged to a column for concentration and recovery of the methanol which is then returned to the extraction step.

Mercaptan reductions of 99 per cent and better are regularly obtained. Presently operating commercial units are processing gasolines containing as low as 0.13 per cent mercaptan to as high as 0.25 per cent mercaptan in profitable operations with octane-number improvements at the 3-cc. TEL concentration of 1 to 3 or more depending on the mercaptan-sulfur content of the untreated gasoline.

This process is the result of years of large-scale pilot-plant development by Atlantic Refining Co., and is licensed by Universal Oil Products Co., Chicago.



Gray Treating Process

THIS process is designed to remove both mercaptan and nonmercaptan sulfur from straightrun or cracked distillates or mixtures of these fuels. Either aviation or motor fuels may be processed. It may also be employed to process diesel oils (fuels) and distillate fuels for sulfur reduction. The operation consists essentially of passing the vapors of the stock to be treated through clay.

After being heated to about 700° F., straightrun gasoline, for example, is passed through a tower packed with 16-60 mesh clay or earth. Space velocity, temperature, and other operating conditions are determined by the nature of the charge and the degree of desulfurization required. Lower pressures consistent with the velocity required to pass the stock through the unit are more favorable to sulfur removal. Treating of cracked stocks is accomplished usually by mixing with straightrun material. Gum constituents of cracked distillates are also removed during the process.

Cracked and Straightrun Gasoline

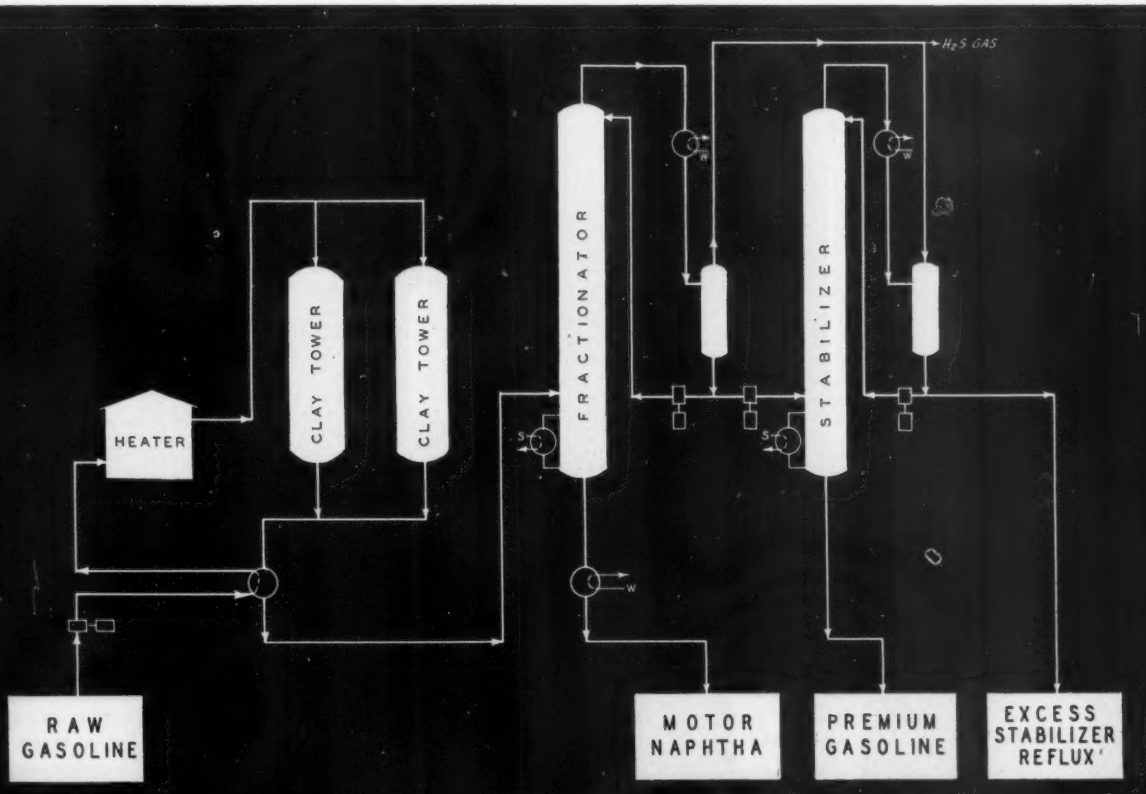
Practically all mercaptan sulfur, along with a large portion of sulfides and disulfides present, is removed in the treatment. Sulfur compounds are converted catalytically to hydrogen sulfide which is removed by caustic washing after condensing. When treating high-sulfur-content gasoline it is often better to remove most of the H_2S by stabilizing the treated product before caustic washing.

Straightrun gasolines give yields of 5,000 bbl. per ton of clay, while with cracked distillates the yields are of the range of 800 to 1,000 bbl. per ton. When treating cracked material an after-fractionator is usually employed to remove any polymers which may be formed during the treatment.

Economical Catalyst

The low cost of the catalyst employed in this process plus lead susceptibility improvement of the treated product makes treatment by the process economical in many instances. The solid adsorbent-type catalyst is available readily in various grades. Because of the wide selection of fullers earth accessible to the industry the material is an ideal catalyst, from an economic standpoint, for the process.

This process is licensed by Texaco Development Corp., New York.



Super Fraction-ation

SUPERFRACTIONATION units have been used extensively for the production of high-octane concentrates of isohexanes, isoheptanes, and isooctanes. The flow sheet illustrates a typical operation for the production of isohexane and isoheptane concentrates in a three-tower plant. In this operation the feed stock has been previously depentanized (in some situations the depentanization is accomplished in the same plant) and the main purpose is the production of blending stocks for high-octane gasoline and low-octane-number stocks which are to be reformed.

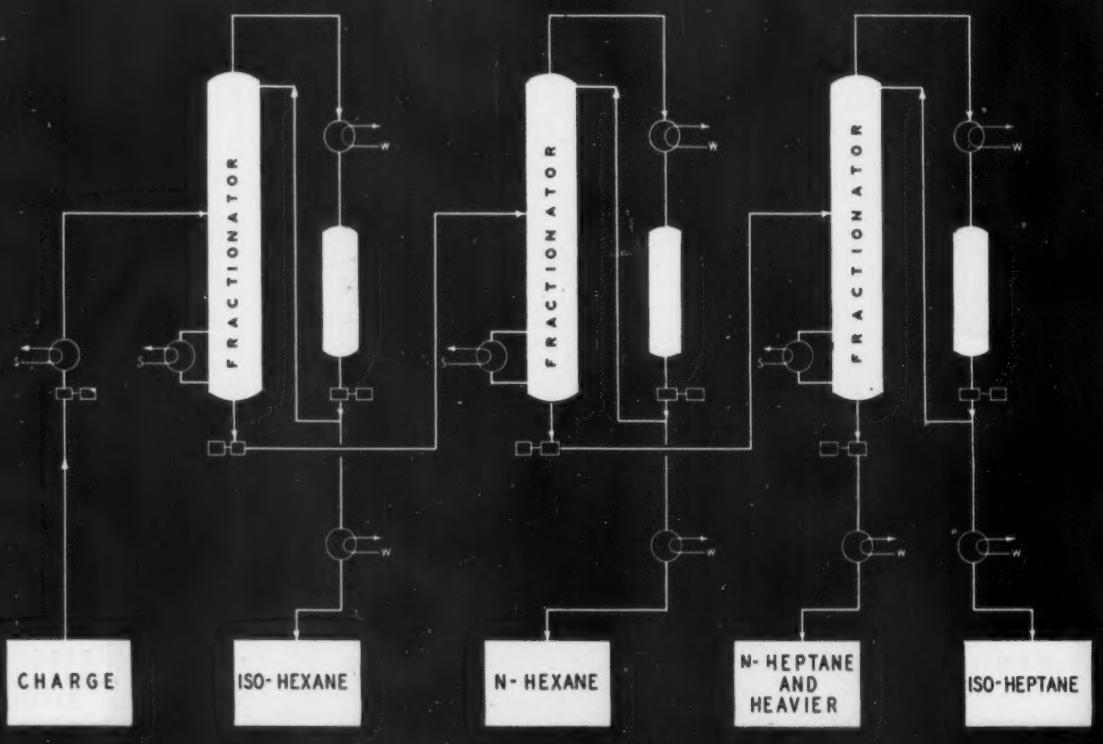
The unit has operating flexibility so that the towers may be operated in any order and sequence. For example, any overhead product can be charged to either one of the remaining two towers. To utilize all equipment to the best advantage and operate near the maximum capacity, the three towers and associated apparatus may be of different size. Thus, any product of high purity and yield may be removed in the largest tower, another product of low purity and yield may be removed in the smallest tower. The best arrangement of towers is possible only after a careful study of such factors as yield, purity, location of fractions in the charge, and boiling points of distillates and residues.

The location of the optimum feed plate is another factor that must be given careful attention for high-purity products. The temperature of the feed, the theoretical minimum reflux ratio and the minimum number of plates are also considered in the design of such units.

In some cases the purity of a product is too high to be obtained in a single tower of reasonable size. However, it may be obtained by concentrating in two steps or by operating two towers in series.

Where the yield of one product is high, it may be an advantage to operate two of the towers in parallel. Many other arrangements are possible, hence flexibility is of prime importance in that it permits the refiner to handle stocks of widely varying characteristics.

This diagram and discussion were supplied by The Lummus Co.



Ethylene Separation

ETHYLENE may be produced by the pyrolysis of ethane, propane, or heavier materials including reduced crudes, by short time, high temperature pyrolysis, and may be recovered from oil refinery gases where it is the byproduct of relatively low temperature thermal and catalytic cracking operations. The high temperature cracking may be carried out in the presence of hot granular refractory or may be accomplished in tubular furnaces. The most important source materials for ethylene pyrolysis at the present time are ethane and propane.

Separation of Ethane and Propylene

The fractionating absorber is the most important unit in the plant in that it makes the separation between methane and ethylene. A portion of the aromatic distillate produced in the process is circulated over the absorber. The rich oil from the absorber flows to the deethanizer where the split is made between ethane and propylene.

Propylene May be Produced

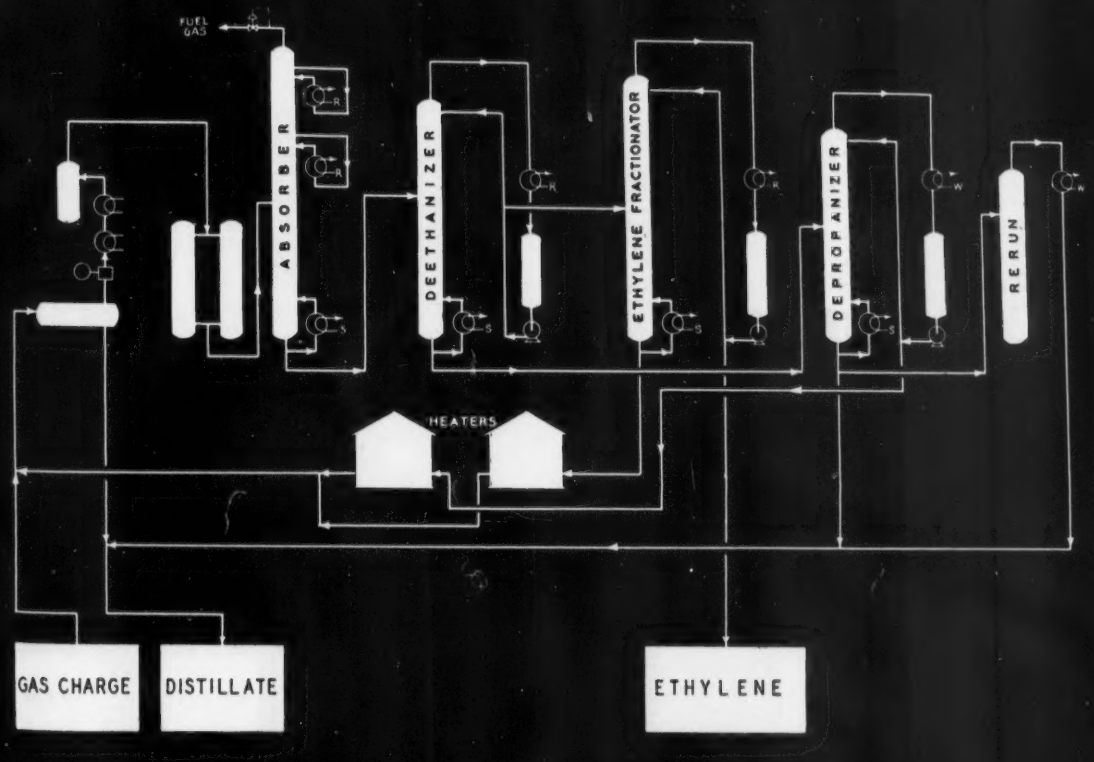
Where the production of propylene is required, an additional tower may be incorporated to separate the propylene from the propane, which is recycled to the pyrolysis step. If propylene of only moderate purity is required, then this tower is not necessary since the propane-propylene stream contains negligible amounts of olefins other than propylene. Overhead from this tower flows to the ethylene fractionator where the split is made between ethylene and ethane.

Aromatic materials removed from the bottom of the depropanizer are used for absorber lean oil as required, with the balance being delivered to aromatic distillate production. A small rerun tower is provided for eliminating heavy polymer which builds up in the aromatic distillate that is recirculated through the system.

In this system refrigeration is required in the absorber, the deethanizer and the ethylene fractionator. However, the refrigeration level is from 0° F. upwards and the refrigeration load is therefore moderate.

Driers are provided for reducing the water-vapor dew point of the absorber charge to less than —40° F., in order to prevent the formation of ice and hydrates over prolonged periods.

This diagram and discussion were supplied by The Lummus Co.



Duo-Sol Process

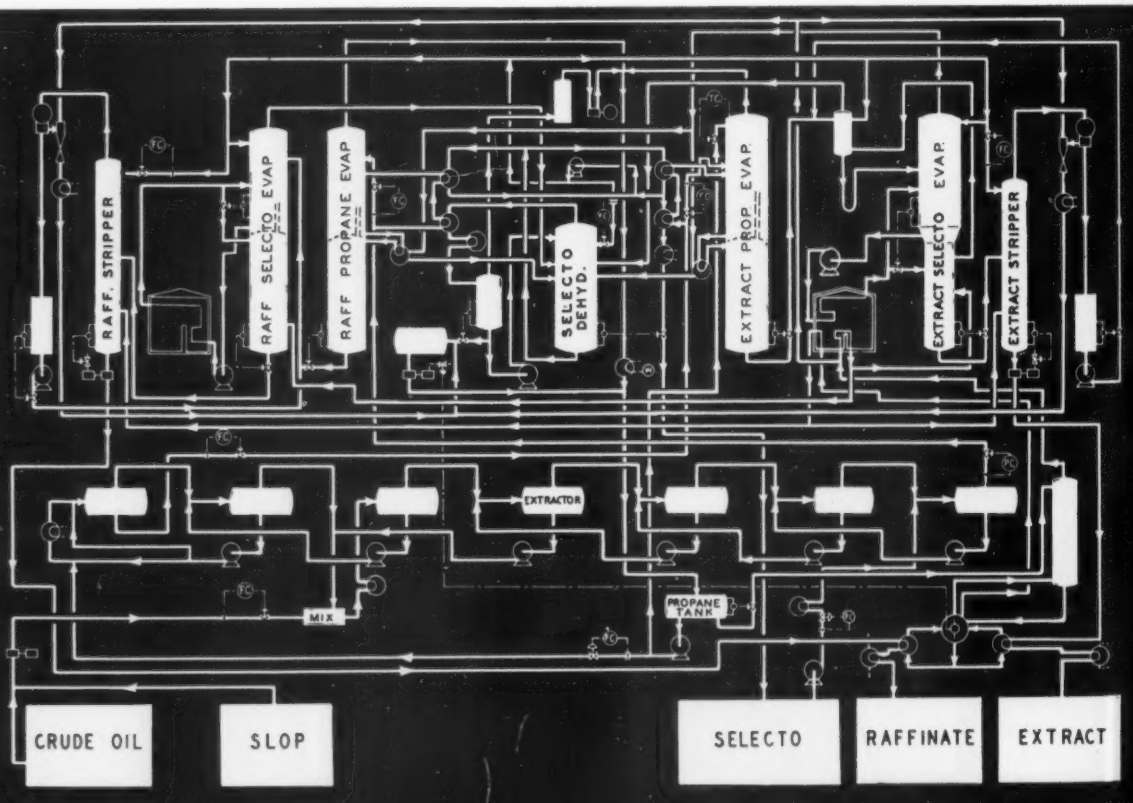
TWO practically immiscible solvents, liquid propane the raffinate solvent, and a liquid known as Selecto (a blend of phenol and cresol) the extract or reject solvent, are employed in the Duo-Sol process. Both serve to produce the two components, raffinate and extract.

Liquid propane is introduced into one end of the extraction system, the Selecto solvent into the opposite end of the system. The raw charge stock enters at an intermediate point. A series of mixing and settling-separating zones comprise the part of the process in which the two countercurrent solvents and the charge are mixed and the two resulting solutions are separated. The propane solution differs widely from the extract solution and settling is relatively rapid by gravity. Operation is maintained at sufficient pressure to keep the propane phase in liquid form, and at a temperature of 90° to 150° F. through a seven-stage system.

Solvent is recovered in separate equipment but in the same three general steps. Under relatively high pressure (about 250 psig.), the propane is evaporated from each solution, a large percentage being recovered from the raffinate phase and only a small amount from the extract phase. The relatively high-boiling Selecto is recovered at intermediate pressure (about 70 psig.). Each phase is then stripped of solvent under vacuum to recover the last traces of solvents and to strip the finished products of solvents. Heat exchange between the higher-temperature Selecto extract fraction and the lower-boiling propane fraction is used to vaporize the propane.

Water and stripping steam in the process are maintained in a closed system. All Selecto vapors containing water vapor enter a dehydrating tower from which the dry solvent is removed as a bottoms stream, and from which an overhead stream (vapor), which contains about 10 per cent Selecto, a constant-boiling mixture, is taken. The water-containing Selecto is charged to a propane surge tank, where propane absorbs most of the other solvent. Water containing only a very small quantity of Selecto is employed as reflux for a tower in the steam-generating system. Overhead from this tower contains all the Selecto in the stripping steam feed. Condensate from vacuum jet condensers and from vacuum towers is returned to the water system.

This process is licensed by Max B. Miller & Co., New York.



Methyl Ethyl Ketone

THIS process employs a mixture of dimethyl ketone (acetone) or methylethyl ketone and benzol to obtain dewaxed oil with low pour test equal to or within a few degrees of the dewaxing temperature. Oils, which may be either of distillate or residual-stock origin, are free from wax cloud when so treated.

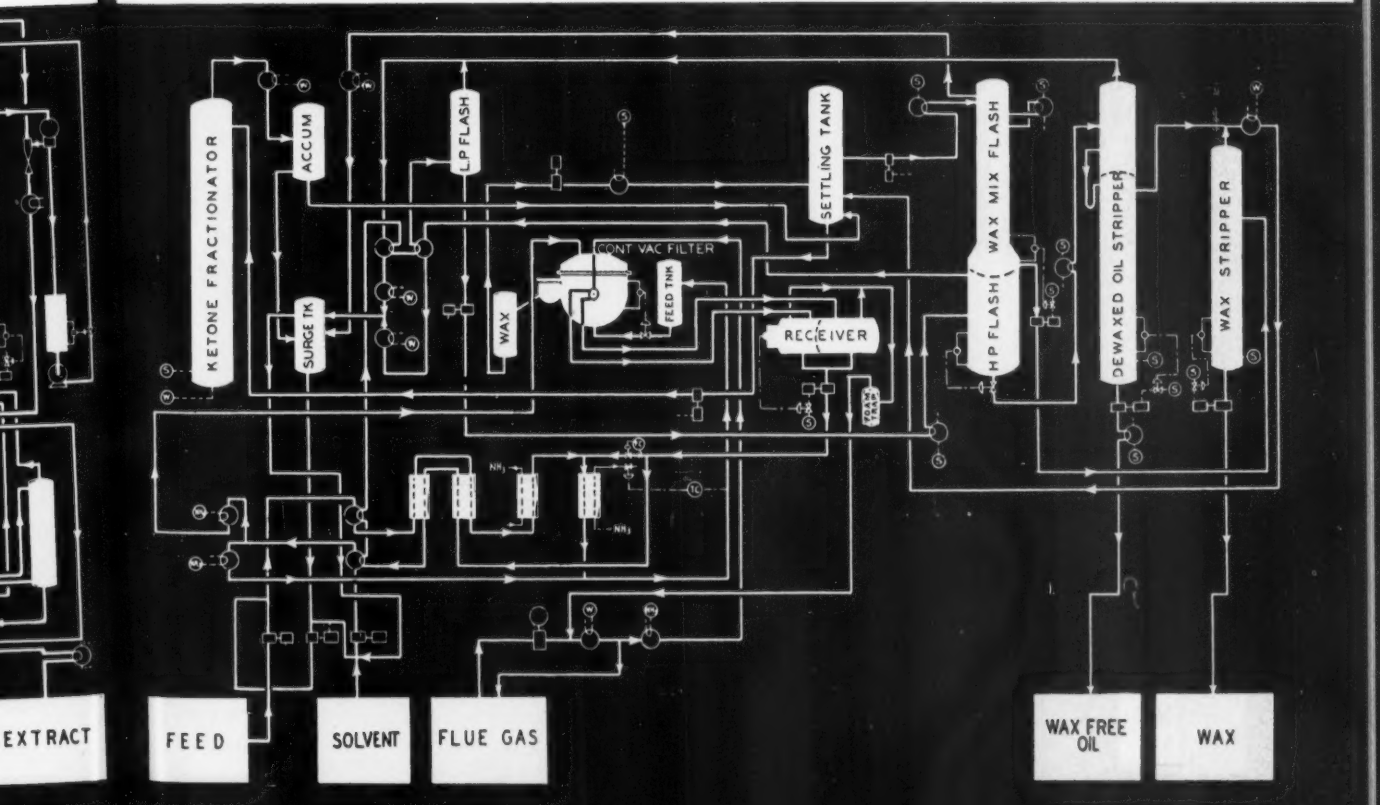
Oils containing wax are mixed with the solvent and charged to conventional double-pipe exchangers and chillers equipped with a suitable type scraper for removing wax from the chilling surfaces. Approximately two-thirds of the refrigeration for the charge mix is obtained by interchange with the outgoing dewaxed oil solution and the remaining third by direct expansion of ammonia. Chilled mix is discharged from the chillers into a filter feed tank from which it flows by gravity to drum-type continuous vacuum filters in which a constant level is maintained. Vacuum is applied to the filtrate system by a conventional vacuum pump. The wax cake formed on the filter is washed substantially free of oil by a directly applied displacement wash.

Solvent is evaporated in two stages. Approximately half of the solvent is vaporized at atmospheric pressure by exchange with solvent vapors, obtained from either a fired or steam-heated evaporator. This evaporator is fed by unvaporized oil-solvent solution from the primary evaporator.

This wax-cake mixture composed of wax and solvent is pumped from the filter through exchange and heating equipment to a surge tank which is maintained at about 130° F. Water inadvertently entering the system crystallizes with the wax in the chillers is removed by the filters with the wax cake and is separated from the wax in the heated surge tank where excess water settles out. The separated water is pumped to the ketone stripper for recovery of solvent and is then removed as solvent-free water from the system. The solution of wax in solvent is pumped from the surge tank through solvent-recovery and wax-stripping equipment.

This process is shown to be adaptable to production of wax concurrently with the production of low-pour-test oils. Such an adaptation is discussed under wax manufacture (page 158 of this section).

This process is licensed by Texaco Development Corp., New York, N. Y.



Phenol Treating

PHENOL extraction, for lubricating oils, is a liquid-to-liquid extraction process for improving viscosity index and oxidation resistance, and for reducing carbon and sludge-forming tendencies.

The process is employed successfully either before or after dewaxing on both distillate and residual oils from all types of crudes. The selective solvent employed—phenol—gives high yields of desired products and has exceptional stability. The solvent is continuously reused, with low losses (0.01 per cent of the total solvent circulated per day in well-operated plants). The high solvent power of phenol necessitates only comparatively low ratios of solvent to oil.

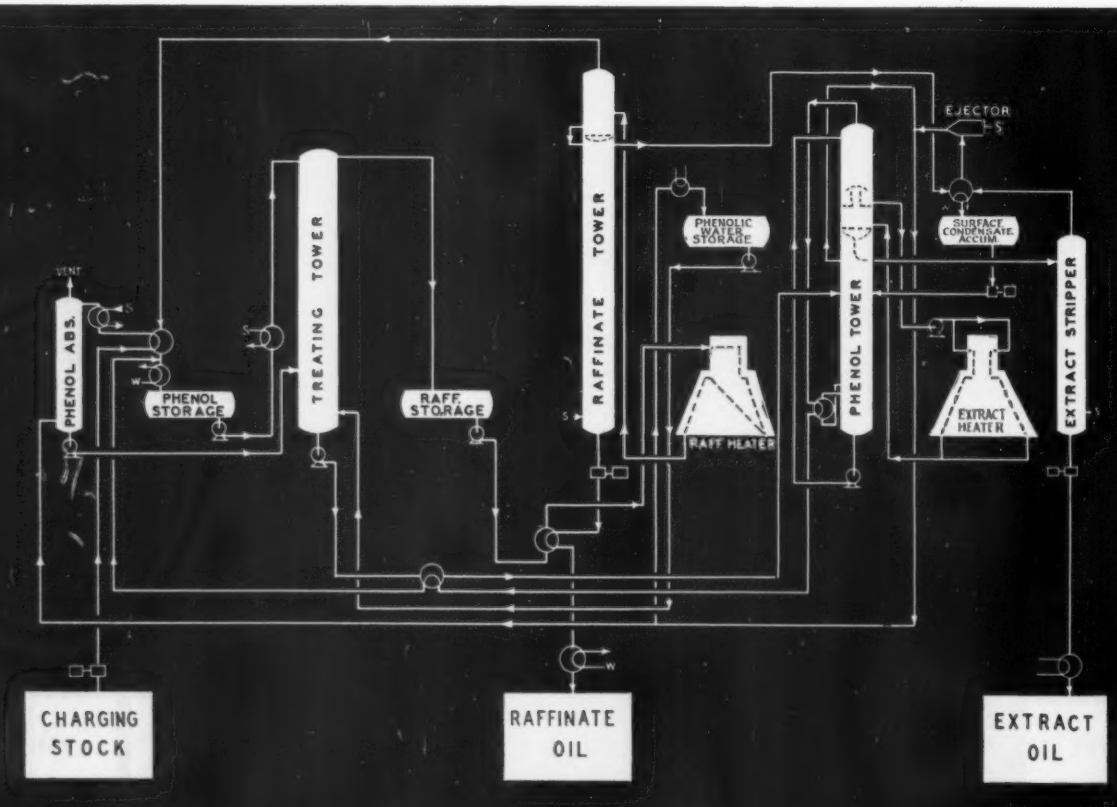
Raw stock and dry phenol are fed into the treating tower. Prior to entering the treating tower, the feed stock flows through the phenol absorber tower to remove the remaining phenol from process water being discharged from the plant.

Raffinate phase is withdrawn from the top of the treating tower to the raffinate storage drum from which it is fed through a heat exchanger, exchanging heat with the treated raffinate oil, thence through a coil in the raffinate furnace and is flashed into the evaporator section of the raffinate tower at substantially atmospheric pressure. Phenol vapor recovered in this section flows to the phenol condenser and enters the phenol storage tank.

The extract phase is withdrawn from the bottom of the treating tower, fed through heat exchangers, and enters the drying section of the phenol tower in which all water is removed as constant-boiling phenolic water vapor. The phenolic water vapor leaving the top of this section is condensed and enters the phenolic water drum from which is drawn reflux for the drying section, as well as the water required for modification of solvent at the bottom of the treating tower.

Dry extract solution is pumped from the bottom of the drying section of the phenol tower to the top of the evaporator section of the phenol tower where a portion of the solvent is flashed off. Phenol vapor recovered in this section flows through exchangers into the phenol storage drum. The remaining extract drops to a pan in the evaporator section of the phenol tower and is pumped through a coil in the extract furnace returning to a point below the the pan in the evaporator section of the phenol tower.

M. W. Kellogg Co. is licensing agent for this process. Licenses are under the patents of Standard Oil Co. (New Jersey), Union Oil Co. of California, Standard Oil Co. (Indiana), and M. W. Kellogg Co.



Furfural Treating

FURFURAL (furfuraldehyde), an extractive solvent, is employed in refining lubricating oils and diesel fuel oils. The process shown in the diagram operates to mix furfural solvent countercurrently with raw lubricating or other stock, separating the two immiscible layers by setting and recovering solvent from each layer. Furfural is stable and highly selective for the nonparaffinic components of these heavy fractions. This extractive solvent is nonacidic and nontoxic, separates quickly from oil because of its high specific gravity, and its boiling point of 323° F. permits recovery from extract or raffinate by distillation.

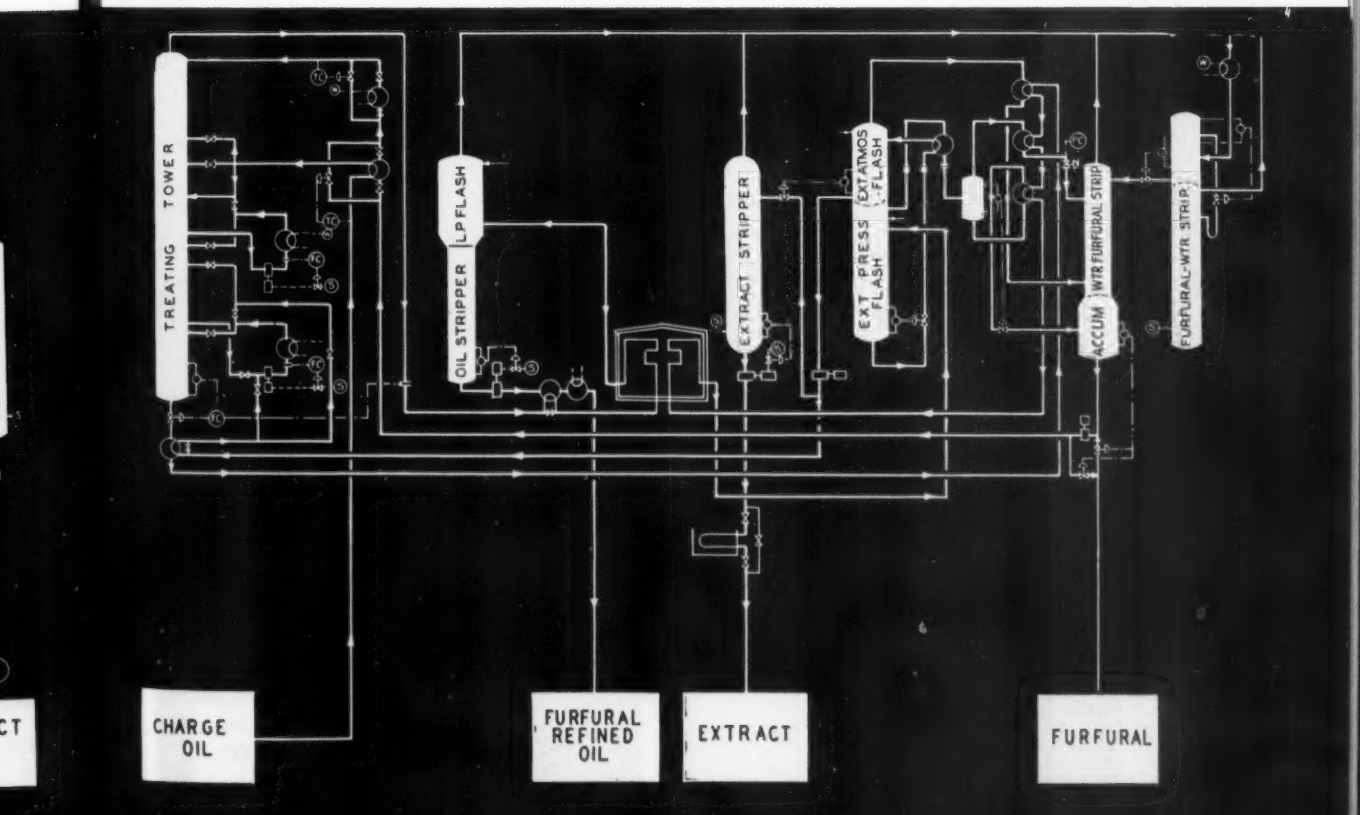
Untreated oil is fed to the extraction tower at a temperature of 110° to 200° F., depending on the nature of the oil. Furfural enters the tower top at temperatures up to 290° F. The oil is the continuous phase and the solvent the dispersed phase through a raschig-ring-packed extraction tower. A wide temperature difference is maintained between top and bottom of the extraction tower. Extract-laden solvent is withdrawn continuously from the tower bottom, while the refined-oil phase, containing a small amount of dissolved furfural, is withdrawn from its top.

To improve stripping action on the extract phase a stream of substantially solvent-free extract is returned to the tower near its bottom. This arrangement serves to displace any desirable oil dissolved in the extract solution thereby increasing the yield of oil of any given quality obtainable from any charge stock.

Solvent recovery is accomplished by continuous distillation and fractionation of the furfural from each product stream from the extraction tower and by steam stripping each product. Two streams of water solvent are obtained, one rich, one lean in furfural. A constant-boiling water-solvent mixture is taken overhead from two towers, for redistillation, while dry furfural is obtained from one tower and practically solvent-free water from the other. The loss of solvent is reported to be as low as 0.03 per cent.

Distillate and residual stocks, ranging from diesel fuel oil to high-viscosity lubricating-oil stocks of more than 200 seconds S.S.U. viscosity at 210° F., are treated with furfural.

This process is licensed by Texaco Development Corp., New York.



Propane Deasphalting

PROPANE deasphalting is a liquid-to-liquid extraction process employing propane as a solvent for the purpose of separating asphalt, color bodies, and other undesirable constituents from reduced crudes and for fractionating the clean oil thus produced into portions having different viscosities.

Ability of the process to produce oil of excellent color and low carbon residue is completely independent of the asphalt content of the reduced crude. This fact, coupled with a low operating cost, makes it possible to produce lubricating oils from reduced crudes previously considered unsuited for the purpose.

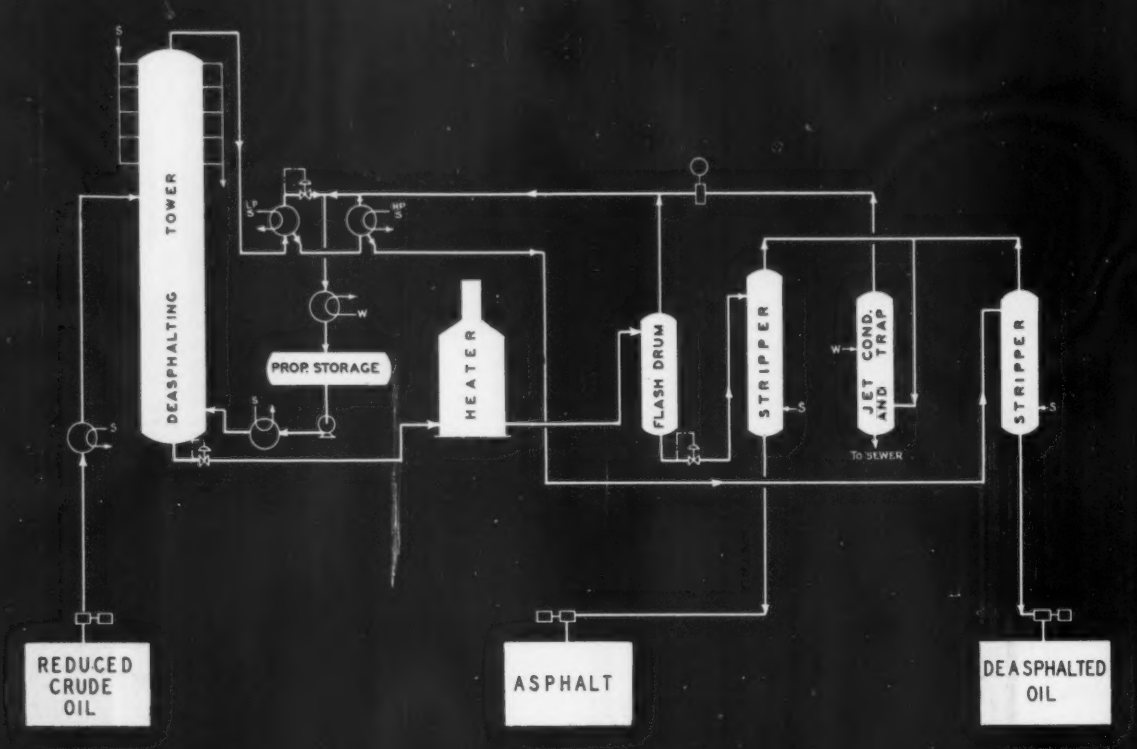
The process is also employed for fractionation of the deasphalted oil into two or more portions. By a simple variation of operating conditions, the highly viscous oil portions of reduced crudes may be separated into as many different fractions as is desired. Because all separations made with propane are carried out at relatively low temperatures, no cracking occurs.

Reduced crude is pumped through a steam heater into the upper portion of the deasphalting tower. Propane is pumped into the lower portion of the deasphalting tower from where it flows upward countercurrently to the descending asphalt phase.

Deasphalted oil is withdrawn overhead and flows to a low-pressure-steam propane evaporator, where a large amount of propane is flashed overhead through a condenser into the propane storage tank. The deasphalted oil-propane solution flows from the low-pressure-steam propane evaporator to the high-pressure-steam propane evaporator where the majority of the remaining propane is flashed off, joining the stream from the low-pressure-steam propane evaporator. The oil flows from the high-pressure-steam evaporator into a steam stripper, where the remaining propane is removed.

The asphalt solution is withdrawn from the bottom of the deasphalting tower and passes through a furnace and thence to a flash drum where the greater part of the propane is flashed overhead, joining the combined propane streams from the low-pressure and high-pressure-steam propane evaporators. The asphalt with remaining small percentage of propane is withdrawn from the bottom of the flash drum into a steam stripper, where the remaining propane is removed.

M. W. Kellogg Co. is licensing agent for this process. Licenses granted are under the patents of Standard Oil Co. (New Jersey), Union Oil Co. of California, Standard Oil Co. (Indiana), and M. W. Kellogg Co.



Solvent Extraction By SO_2

THE Edeleanu process uses liquid sulfur dioxide as extractive solvent. Its application covers a wide range of petroleum-refining operations and includes the manufacture of aromatic and aliphatic solvents, high-quality kerosines, diesel fuels, and lubricating oils.

The value of sulfur dioxide as an extractive solvent rests upon its high selectivity, high specific gravity, and low boiling point. The solubility of aromatic hydrocarbons in SO_2 is unlimited, but that of paraffinic and naphthenic hydrocarbons decreases greatly as the treating temperature is reduced. At constant temperature the solubility of the SO_2 for the lower-boiling paraffines and naphthenes is greater than for the heavier components, which is the reason why naphthas and kerosines must be treated at lower temperatures than the heavier petroleum fractions.

Since sulfur dioxide is also a good refrigerant, it is in most cases not necessary to use an extraneous refrigerant in the Edeleanu plant. Instead, one and the same compressors and condensers will serve for the refrigeration and will also handle the solvent from the recovery systems for extract and raffinate.

The flow diagram shows a typical Edeleanu plant for treatment of naphtha, kerosine, gas oil, or light lube-oil fractions.

The SO_2 treatment of naphthas for production of aromatic and paraffinic solvents is usually carried out at temperatures from 0° to 10° F. and requires from 50 to 100 per cent solvent.

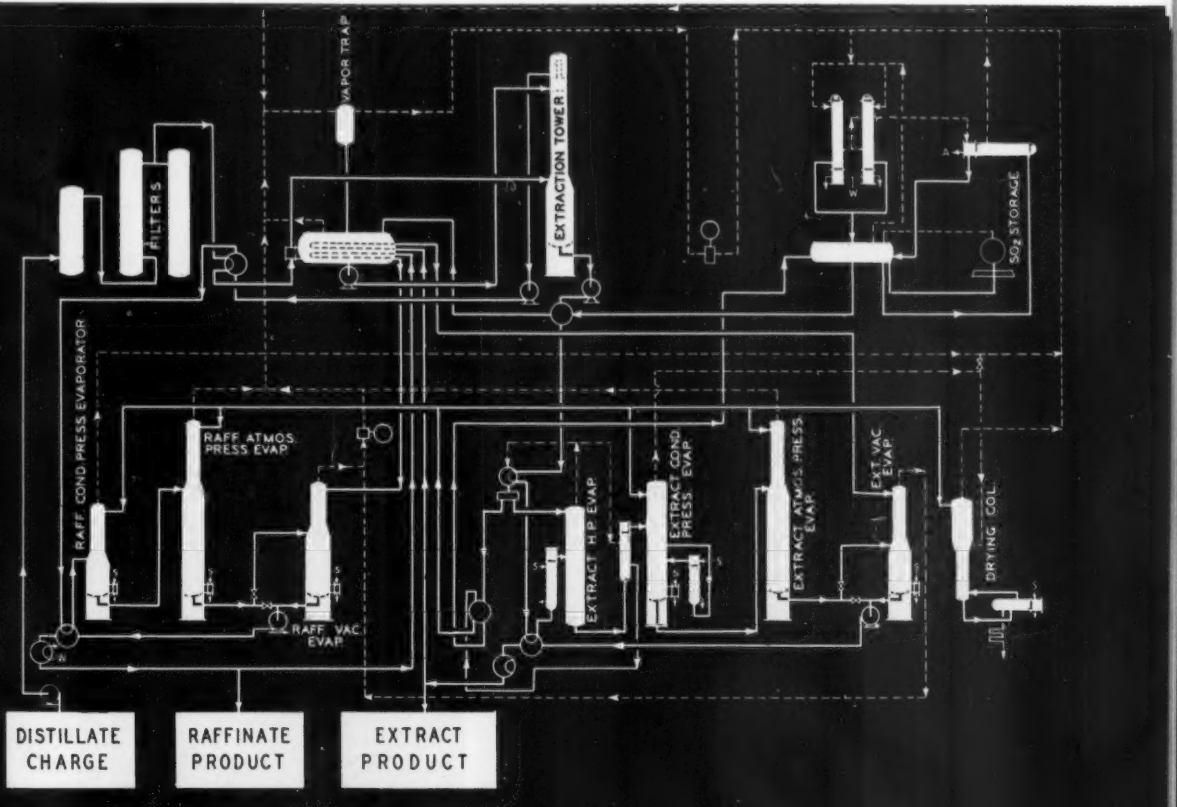
Kerosines are usually treated with 75 to 100 per cent SO_2 at 10° to 20° F. Depending upon the nature of the charge and upon treating conditions 70-90 per cent of the total sulfur will be removed.

In recent years the process has been employed for the production of diesel fuels from virgin and cracked gasolines.

The SO_2 process may also be used to advantage to upgrade catalytic cycle stocks. The raffinates from such stocks approach the virgin gas-oil charge in quality. Thus, the process will furnish a high gasoline yield with the least use of cracking-plant capacity.

Treatment of heavier petroleum fractions for the manufacture of spray oils, transformer oils, and light motor oils requires solvent ratios in the neighborhood of 200 per cent, at temperatures ranging from 20° to 60° F. The stocks will usually require a slight aftertreatment with acid.

Diagram and discussion on this process were supplied by E. B. Badger & Sons Co., Boston.



Propane Dewaxing

PROPANE dewaxing is a lubricating-oil process for separating wax from crude oil. The solvent, propane, is the only extraneous material used in the process since it serves both as a refrigerant and as a solvent for the oil.

Economic features of the process are its low operating cost and wide adaptability to any type of lubricating stock. High yields of dewaxed oil of zero pour test or lower and wax of low oil content are obtained.

Oil and propane are charged continuously under flow control, warmed to dissolve all the wax, and sent to a chilling vessel in which reduction of temperature to approximately —40° F. is effected by allowing propane to vaporize directly from the solution.

Wax crystallizes out at this low temperature and is separated from the oil on a continuous rotary pressure filter of most modern design.

The filter cake is washed with cold liquid propane to remove oil adhering to the wax crystals and then transferred by means of a screw conveyor and wax pump to propane-recovery equipment.

The dewaxed filtrate also is sent to a propane-recovery unit. Both end products—dewaxed oil and wax—are pumped from the strippers to storage tanks. Over-all loss of the propane solvent is low and control methods for the process are relatively simple.

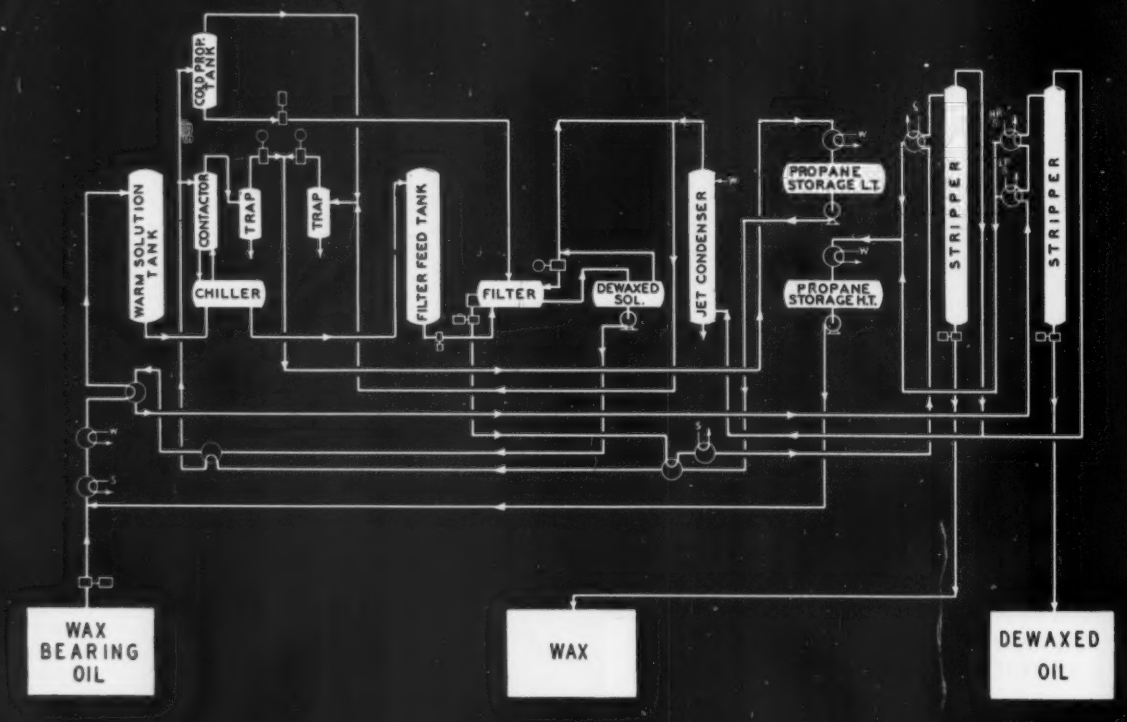
Two compressors are employed in the low temperature propane circuit of the process. The high temperature circuit connects into the unit's propane evaporators. Propane vapors from the evaporators are condensed and delivered into high temperature storage from which the solvent liquid is pumped into the wax-bearing oil charge stream. The two strippers in the process are connected to a jet condenser which in turn is connected into the low temperature propane circuit via the suction side of one of the compressors. Intake of the second of the two compressors in connected only into contactor via a trap.

The low cost of propane, its double duty as a solvent and refrigerant, and its ease of recovery are feautres of the process which make for high efficiency.

Propane dewaxing is often employed in combination with propane deasphalting and acid treatment in propane solution.

M. W. Kellogg Co. is licensing agent for this process. Licenses are under the patents of Standard Oil Co. (New Jersey), Union Oil Co. of California, Standard Oil Co. (Indiana), and M. W. Kellogg Co.

This discussion and flow diagram were prepared by M. W. Kellogg Co.



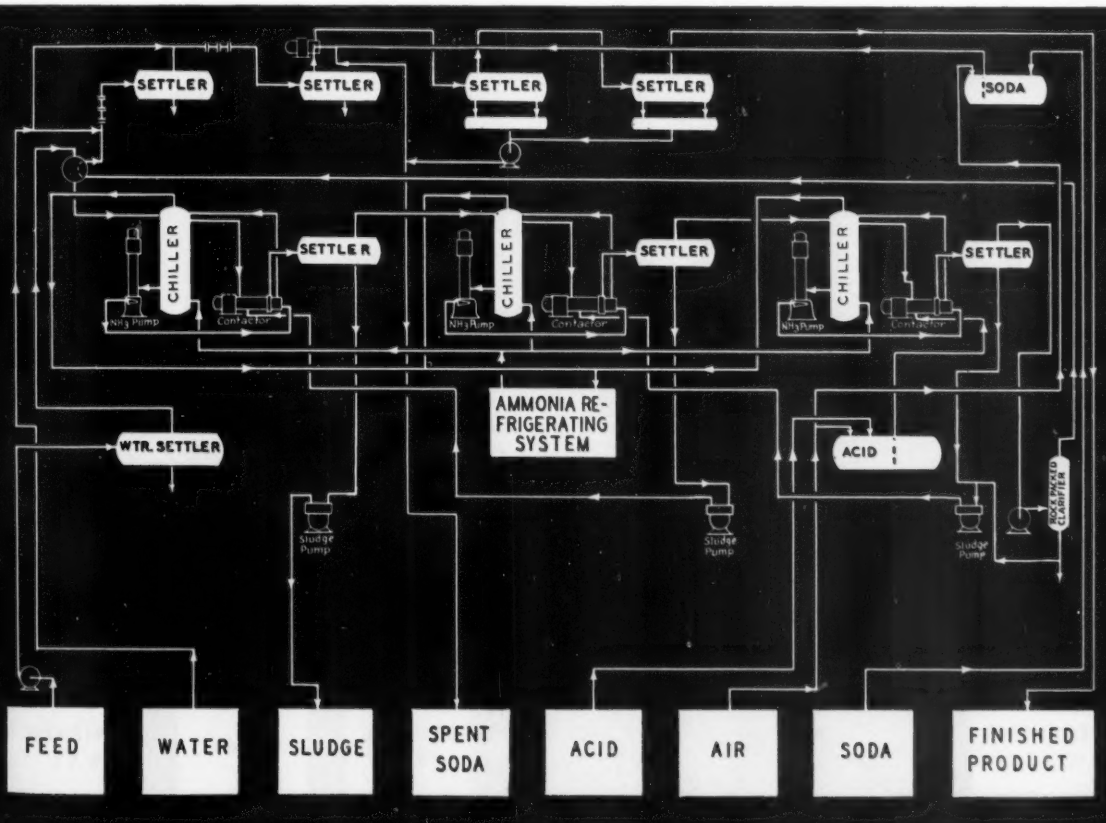
Stratcold Processing

THIS process has been developed for the application of sulfuric acid treating to certain types of petroleum distillates by which the best returns are obtained from this very old reagent, with the practical elimination of drawbacks which are found in the older, more conventional methods of treating with strong H_2SO_4. It consists essentially of quick and intimate mechanical mixing of sulfuric acid in multistage countercurrent flow with the raw stock to be treated while reagent and stock are cooled to low temperatures, and interstage and final separation of the two in settlers.

Refrigeration is employed to cool the charge to predetermined low temperature. Normally three stages are employed in the system to obtain the optimum advantages of the principle. The process is countercurrent, the raw stock entering one end of the stage system and passing through in the opposite direction to that of the acid. In this manner raw stock is brought into contact with twice-used acid, while the twice-treated stock is contacted finally by fresh acid of the maximum strength employed in the given unit. While acid concentration may be varied from plant to plant, 98 per cent acid usually gives the optimum results on most products.

This process is applied generally to cracked naphthas, especially those high in sulfur. A maximum sulfur removal is effected, its licensors state, with the minimum adverse effect on octane number and other desirable properties. For the process in general it is claimed that the maximum utilization of all the acid charged to the system is a decided economy. Acid savings for any given sulfur, gum, or color removal amount to 40-50 per cent of the acid used in conventional processes. Because of high dispersion and separation rates, losses by undesirable polymerization and solution in the reagent are held to a minimum. Such losses from the charge are reduced by 20 to 80 per cent of those sustained by older methods of treating. Entrainment of distillate in the acid-sludge phase is minimized by this process, it is stated. The removal of mercaptan sulfur in the first two stages, also the removal of pyridines and other nitrogen basas in the first two stages, improve color and color stability.

This process was developed by Standard Oil Co. of California and Stratford Development Corp.



Wax Manufacture

THIS process employs solvent (ketone-benzol) in its operations to produce various waxes. Filtration is employed in the separation of wax at low temperatures and finished wax is produced thereby following a wax recovery operation.

Separation of the oil-wax mixture, after cooling to the proper temperature, is accomplished by adding sufficient extra solvent to reduce the mixture viscosity for filtering operations.

Typical of the operations in a unit such as represented by the diagram is that of processing 150-180 S.S.U. viscosity at 100° F. reduced wax distillate or neutral oil. In this operation finished 132°-135° F. melting point wax is produced. The charge oil is first chilled without dilution in double-pipe, scraped-surface chillers.

After the wax has started crystallizing, about 0.1 part of solvent (ketone-benzol) per volume of charge oil is added. As the mixture continues to be chilled and more wax crystallized, an additional amount of solvent is added to reduce the pressure required for pumping the mixture through the cooling equipment. When the desired temperature is reached, for example +35° F., an additional amount of solvent, in the form of recirculated filtrate from a repulping filter or wash filtrate from the primary filter, is added.

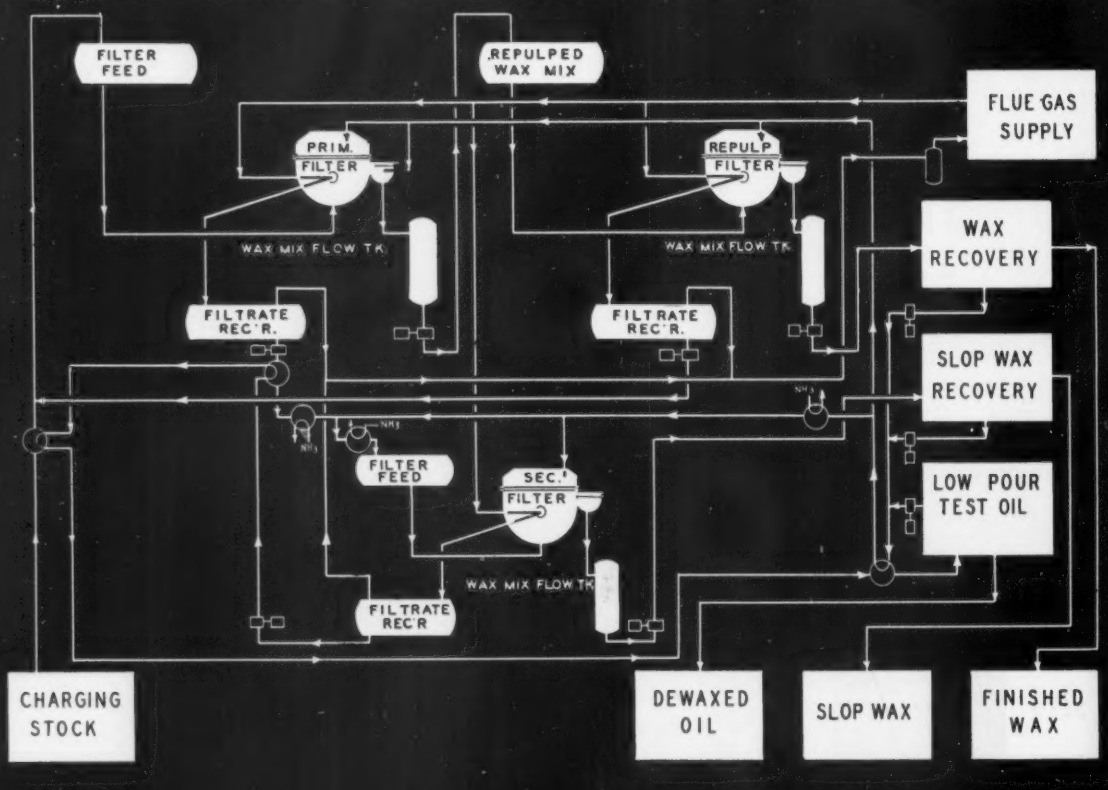
The mixture is then filtered, the oil washed from the wax continuously on the same filter and the wax of desired melting point removed as wax cake from which the solvent is evaporated.

In some cases operations may be necessary for repulping the primary wax to obtain the desired oil content or tensile strength of wax, but in many cases the repulp step is not necessary.

Filtrate from the primary filter is further chilled by exchange and direct cooling, additional solvent added, if required, and filtered in a secondary filter to remove the remaining low-melting-point waxes and produce low-pour-test dewaxed oil.

The operation is continuous and highly economical in the use of solvent, whether producing regular grades of white crystalline wax and dewaxed neutral oils or high-melting-point microcrystalline waxes from distillate or residual oils.

This process is licensed by Texaco Development Corp., New York, and by Union Oil Co., Los Angeles.



Continuous Grease Manufacture

THIS process introduces into the grease-making industry the operation principle in which the Stratco Contactor unit is the important part. By this method the ingredients are weighed accurately and are fed into the contactor as outlined below. The process reduces time cycles greatly, less than 2½ hours for soda-base greases, and 1¼ hours for cup greases, simplifying equipment and procedure.

A typical plant for this process includes:

One or more paddle-type kettles jacketed for oil heating.

One or more Stratco pressure contactors, equipped with high internal circulation and oil jacket heating.

One or more heaters for heating circulating oil as a heating medium for other units in the system.

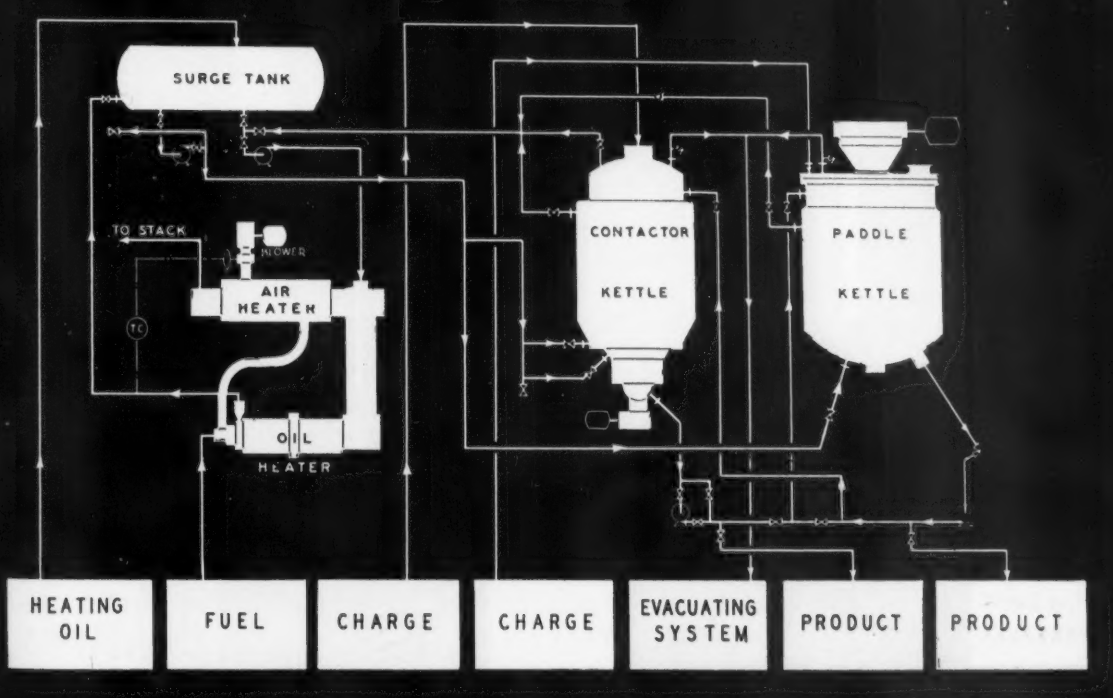
In such a typical unit several hundred different grease products may be made: 10-40 per cent higher yields based on fatty acid used are obtained over conventional soap-making methods, due to the intimacy of contact between alkali and acid.

The oil heater includes a small, inside-fired radiant section and a tubular convection section with forced-draft combustion, and a plate-type air heater.

In operating the system for making, for example, soda fiber greases, fatty acid, or fat up to the required weight is added to the contactor followed by a predetermined amount of petroleum oil, and the mix is heated to some desired temperature, say 190° F. Dry flake caustic soda and the proper amount of water, both weighed, are added. The contactor is sealed, the charge heated and circulated. While this step of soapmaking is being carried out, a small amount of oil, which with that already in the contactor constitutes about one-third of the requirements for the finished grease, is placed in the paddle kettle. When the contactor's contents reach 370° F. or other desired temperature and about 70 psig., the mix is started flowing into the kettle.

After dehydration the remainder of the oil is weighed into the paddle kettle. Immediately after the addition, circulation is started between kettle and contactor and the contactor is again started into operation. Only 4 to 5 minutes are needed to mix the oil and soap thoroughly. At the end of this cycle the grease is ready for packaging, which is carried out for soda greases at about 190° F. Total elapsed time of 2¼ to 2½ hours compares with 24 to 36 hours needed for making these greases by conventional methods.

This discussion and diagram presented courtesy Stratford Development Corp., Kansas City, Mo.



Girbotol Treating

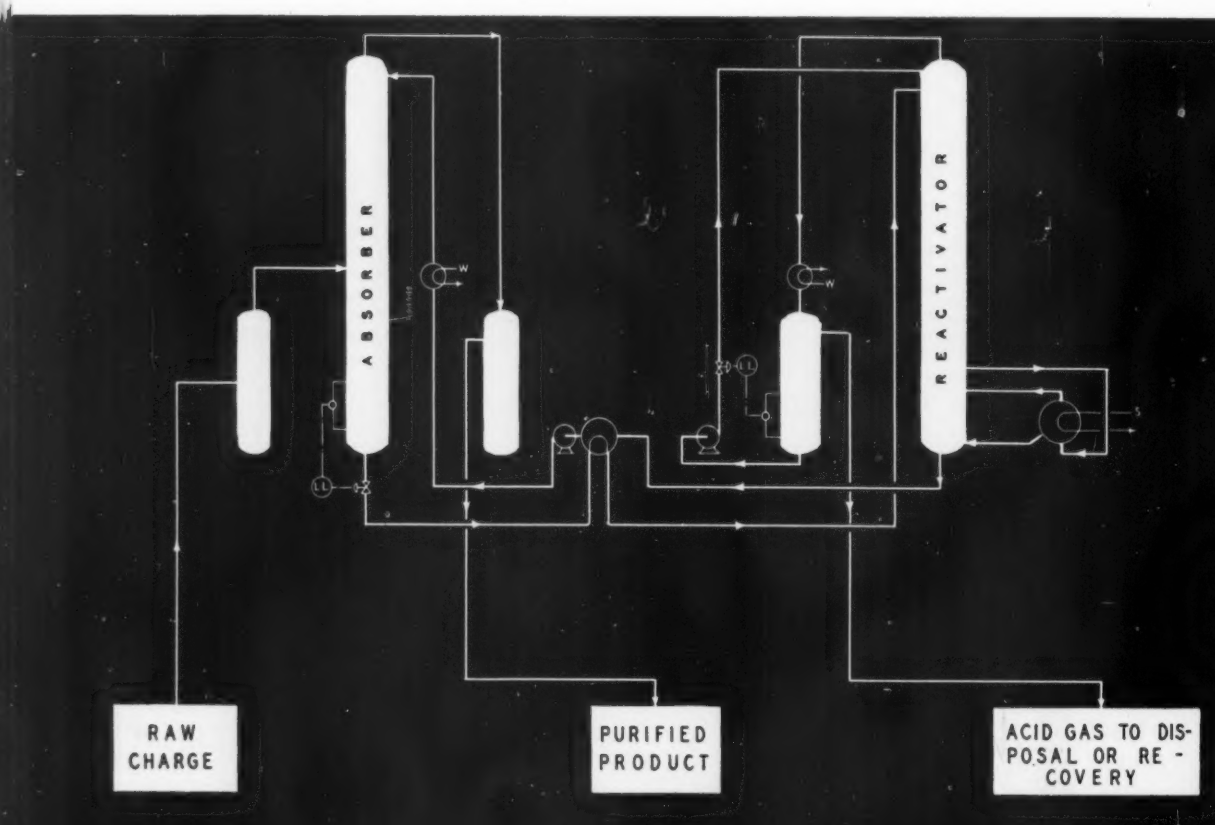
THIS continuous cyclic process separates acidic gases (such as hydrogen sulfide and carbon dioxide) from gases and liquids. The gases and liquids are scrubbed with solutions of amines (organic alkalis) which remove acidic gases from them. The absorbed acidic gases are then separated from the amine solutions by heating which regenerates the solution for further acid gas absorption. The regeneration takes place because amine salts of weak acids dissociate readily at elevated temperatures, and the amines may be separated from the acidic gases they have absorbed at lower temperatures.

The process has numerous applications in the petroleum and natural gas industries: (1) purification of natural gas for pipe-line distribution (including simultaneous hydrogen sulfide removal and dehydration); (2) purification of refinery gases to eliminate corrosion, to reduce atmospheric pollution, and to recover hydrogen sulfide for conversion to elemental sulfur or sulfuric acid; (3) purification of gaseous feed stocks for polymerization and chemical plants; (4) purification of hydrocarbon liquids, including gasolines, propane, butanes, and poly feed stock; (5) removal of carbon dioxide from hydrogen and synthesis gas mixtures; (6) recovery of carbon dioxide for use in producing synthesis gas mixtures.

Equipment and operating cycle of a Girbotol plant are similar to those of an oil-absorption plant. The raw feed (gas or liquid) is passed through a contactor countercurrent to a stream of lean amine solution that removes hydrogen sulfide or carbon dioxide from it. The purified product passes out the top of the contactor to utilization, while the rich amine solution, containing absorbed hydrogen sulfide or carbon dioxide, flows through a heat exchanger to a stripper (reactivator) in which the acid gases are separated from the solution by heating and steam stripping. The acid gas is recovered from the overhead of the reactivator, while the lean solution from the base of the tower is returned to the contactor.

A number of modifications have been introduced into the basic Girbotol plant cycle in recent years. These include solution reactivation under increased pressures, use of antifoaming agents, two-stage absorption and reactivation, solution recovery by distillation or extraction, and the use of mercaptan plant stripping steam for reactivation.

This process is licensed by The Girdler Corp., Louisville.



Hygirtol Hydrogen Manufacture

HYGIRTOL plants manufacture high-purity hydrogen or synthesis gas from hydrocarbons and steam or carbon dioxide. The following processes are employed:

1. The catalytic reaction of hydrocarbons and steam or carbon dioxide to produce carbon oxides and hydrogen. (2) The catalytic oxidation of carbon monoxide with steam to produce carbon dioxide and hydrogen. (3) Carbon dioxide removal from intermediate and product gases, and carbon dioxide recovery from outside sources (by the Girbotol process).

Exact process arrangement in a Hygirtol plant will depend upon composition desired in the product gases. If pure hydrogen is to be produced, as illustrated in the accompanying flow diagram, steam alone is reacted catalytically with a suitable hydrocarbon (natural gas, refinery gases, propane, butane, gasoline, etc.) in the hydrogen furnace at a temperature of about 1,500° F. A mixture of hydrogen, carbon monoxide, and carbon dioxide containing less than 0.1 per cent residual methane is produced. This mixture is cooled at the furnace outlet to about 700° F., and passed through the first-stage carbon monoxide converter, in which the greater part of the carbon monoxide reacts with steam to produce carbon dioxide and hydrogen. At the converter outlet the product gases are cooled to atmospheric temperature by heat exchange and cooling, and the carbon dioxide is removed by the Girbotol process. Two more stages of carbon monoxide conversion and carbon dioxide removal are employed in the plant shown in the flow diagram, to produce a purified hydrogen.

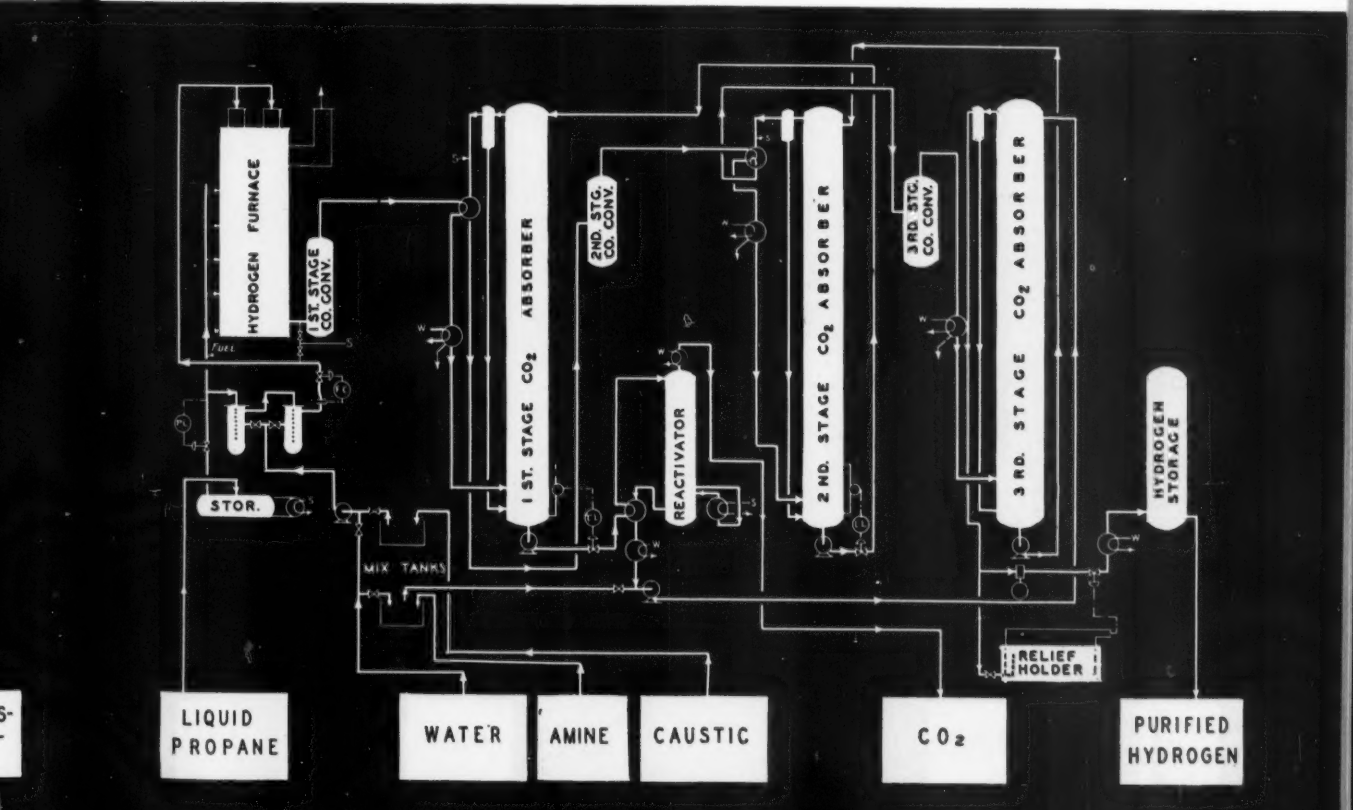
For the production of synthesis gas mixtures of hydrogen and carbon monoxide, carbon dioxide may be introduced into the hydrogen furnace to replace part or all of the steam, in order to increase the carbon monoxide content of the product gases to any desired point (up to about 90 per cent), while the amount of carbon monoxide conversion utilized will be varied.

Hygirtol plants are designed, engineered, and constructed by The Girdler Corp., Louisville.

MATERIAL AND UTILITY REQUIREMENTS PER 1,000 CU. FT. OF HYDROGEN

Material—	Quantity
Natural gas, cu. ft.	*250
Fuel (gas or oil) B.t.u.	250,000
Steam, lb.	380
Cooling water, gal. (30° F. rise)	1,600
Power, kw.h.	2
Chemicals, cost in cents	2

*Or propane (2.75 gal.)



Decoking Process

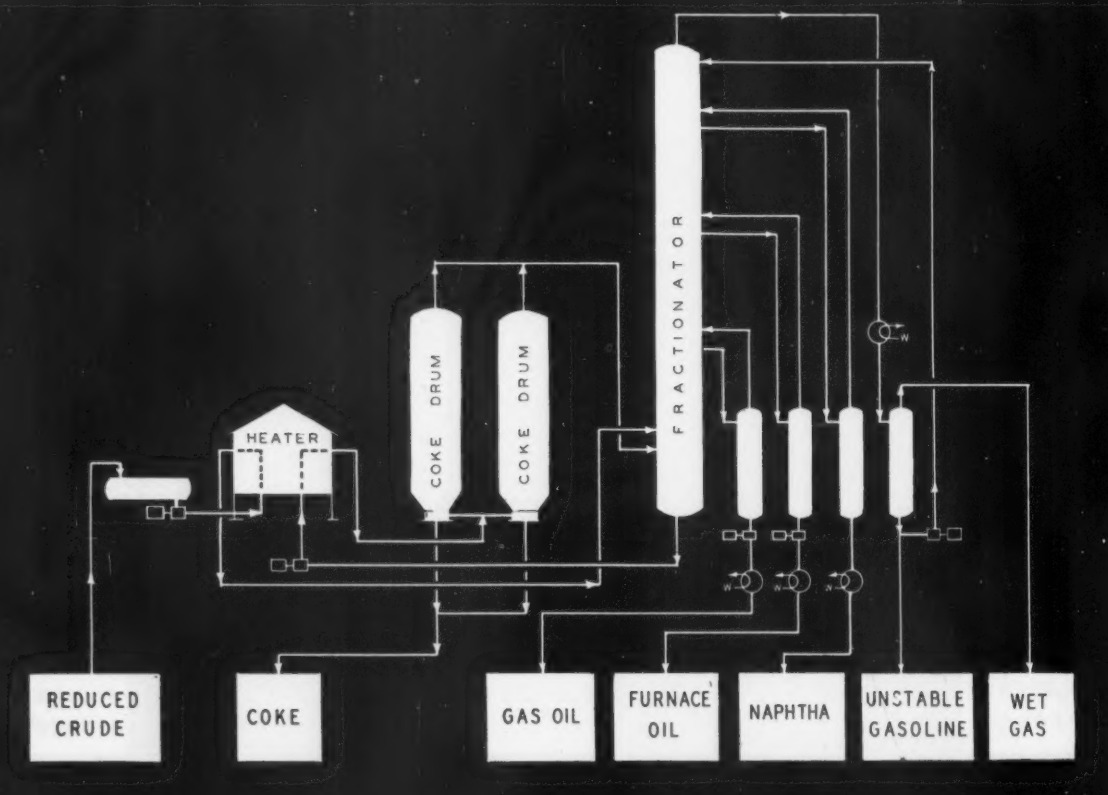
THE modern delayed coking process is operated on a continuous-throughput basis. Operations differ from that of the usual thermal cracking process in that the topped crude, which is heated rapidly, flows to the coking drum where it is coked by its contained heat. Depending on the type of feed stock and desired yields, the drum operates at pressures from 5 to 250 psi.

Feed stocks for catalytic cracking may be prepared in the process. Such stocks are shown to be of high quality and tend to improve catalytic-cracking efficiencies. Topped crude may be reduced further to produce certain types of fuel oils without producing coke.

When processing 30 per cent reduced crude the charge enters the fractionating column at 800°-850° F. Overhead and side streams from the fractionator may be subdivided into two or more streams, including light and medium recycle or furnace-oil (fuel-oil) stock, heavy cracking stock, and other yields. Bottoms from the tower are pumped to a second heater, raised to 900°-975° F., and transferred directly to the coking drums. These coking drums are maintained at any normal temperature up to 920° F. Vaporized fractions from the drums pass into the fractionator. During the "soaking" period, vaporizable portions of the heavy oil are released until the latter is reduced to solid coke, containing only a small quantity of volatile matter. Two or more drums may be used in sequence, one being included in the system until essentially full of coke, it then being disconnected and a fresh, empty drum being switched into the flow to receive the heavy hot oil which in turn is reduced to overhead vapors and solid coke.

The octane ratings of the motor-fuel fractions from coking operations may be related better to the properties (characterization factor) of the feed stock than to the gravity or other physical property. Asphaltic, naphthenic, and similar charge stocks will yield motor fuels of octane number (motor method) of 75-78. Paraffinic stocks will show gasolines of 64-68 octane number or slightly higher. Normally the higher the percentage of conversion (crack per pass) of the charge, the higher the octane number, the lower the over-all yield.

The M. W. Kellogg Co., New York, is licensing agent for this process.



Hydro-Carbon Synthesis

ALL methods and processes which are active now in the oil and allied industries for synthesizing hydrocarbons in quantity are based on the two main reactions brought into prominence by Franz Fischer and Hans Tropsch in the middle 1920's. The first of these reactions has been called the "water gas reaction" by which solid, liquid, or gaseous raw materials, such as coal, coke, heavy oils, or natural gas, or even organic materials of vegetable origin, are converted to a mixture of gases in theoretical proportions according to the equations:

$$\underset{\text{Coal}}{C} + \underset{\text{Steam}}{H_2O} = CO + H_2 \text{ (Synthesis gas)} \quad (1)$$

$$\underset{\text{Methane}}{2CH_4} + O_2 = 2CO + 4H_2 \text{ (Synthesis gas)} \quad (2)$$

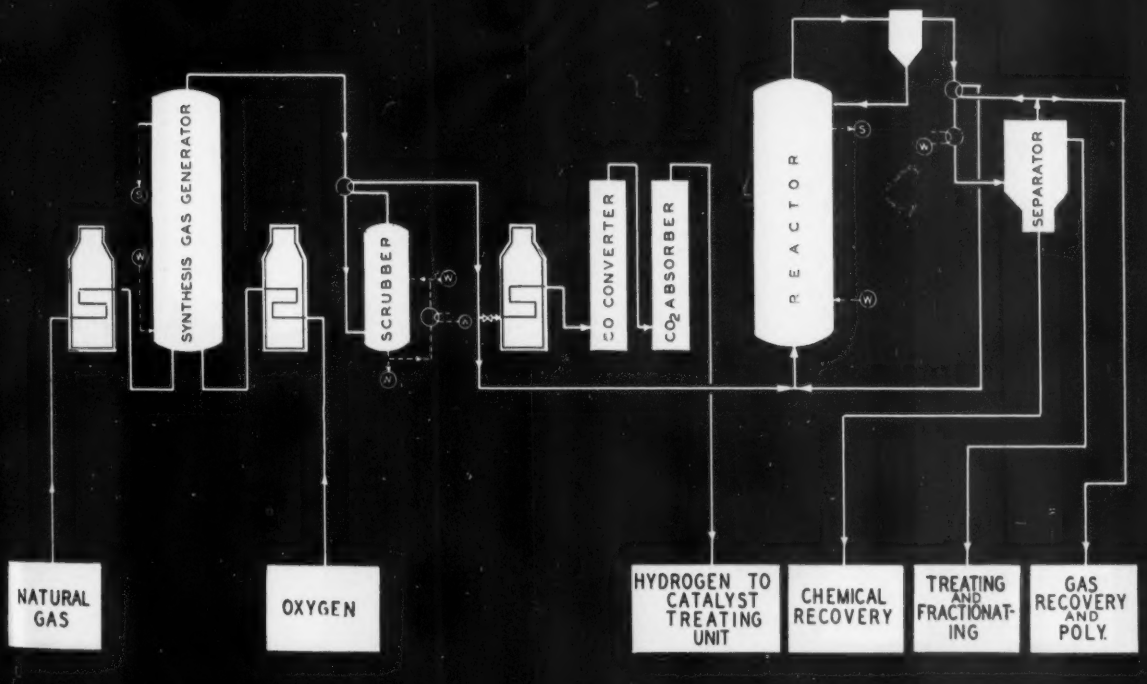
These equations do not include side reactions producing carbon dioxide, and possibly other impurities, which are formed as byproducts.

The second reaction starts with the gas mixture of carbon monoxide and hydrogen, or "synthesis gas," which may have added to it either more monoxide or more hydrogen to change the proportions of these reactants and thus influence the reaction in the desired direction. In the presence of a catalyst these gases react to form hydrocarbons of widely varying molecular weight and structure; alcohols, acids, ketones, and other oxygenated organic derivatives; the hydrocarbon-producing reaction is:

$$6CO + 13H_2 = \underset{\text{Hydrocarbon}}{C_6H_{14}} + 6H_2O \quad (3)$$

Thus, while the synthesis gas may be produced from coal or gas or oil, theoretically from any organic matter, the second step in the synthesis is the same since the gas mixture is identical, or it may be enriched with one or the other component to make up the same reaction mixture regardless of the original source of the reactants.

Two American processes have been developed, using this synthesis, and are available for license. One is the Hydrocol process, developed by the Hydrocarbon Research, Inc.-Texaco Development Co. group; the other is the Synthol process, developed by M. W. Kellogg-Cities Service group of collaborators.



Electric Desalting

THE Petreco electric desalting process provides a widely used method for removing salts and certain other impurities and solid matter from crude oil. The Petreco desalter generally is tied into the crude-charge line after the first bank of heat exchangers, or where the crude is at the proper temperature for desalting.

The charge of salt-bearing crude is pumped to the desalter and heated, fresh water is pumped into the hot crude stream. This mixture flows through the emulsifier which disperses the water into the crude, forming an emulsion. The emulsion, in the desalting unit, is distributed into the electric field and subjected to a high voltage.

Under the influence of the strong electric field, the added water particles and the brine particles are electrically attracted and coalesced. This continues until the coalesced masses attain sufficient weight to gravitate rapidly to the bottom of the desalter. To accelerate complete and rapid separation of the desalted oil from the waste water, a clarifying system operates in the water-oil separation zone.

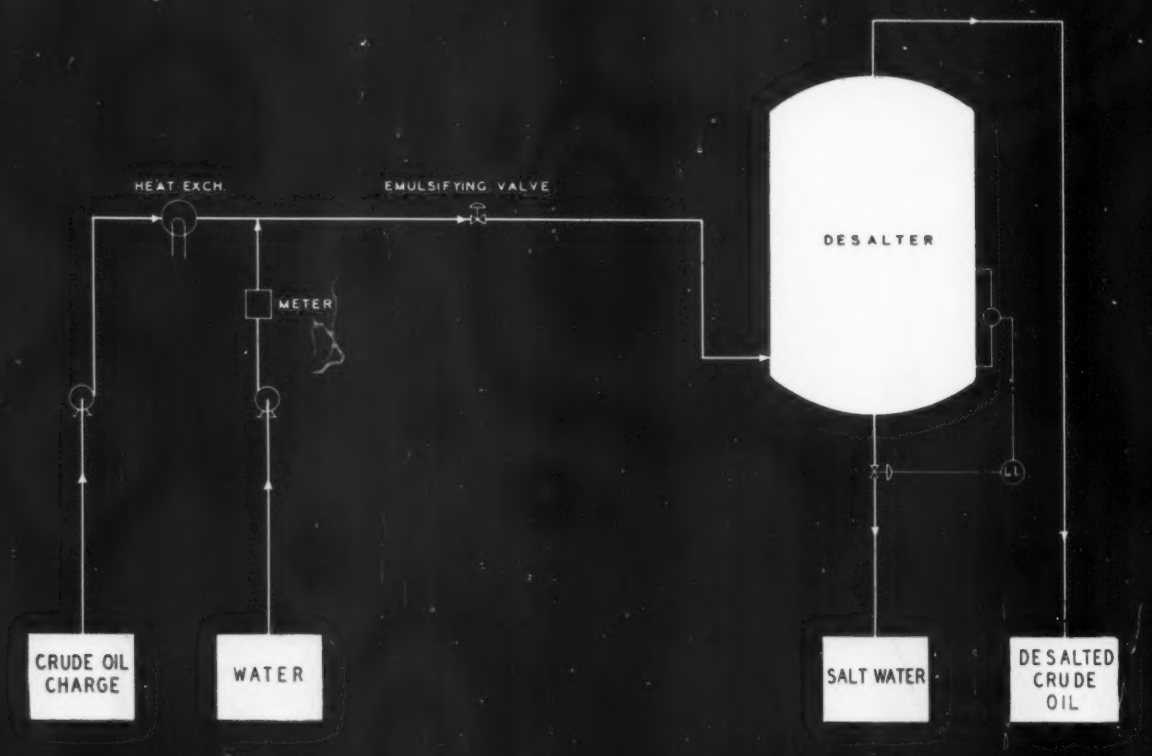
The volume of salt-bearing water drawn off is governed by an automatic liquid-level controller. This effluent usually is discharged to the sewer via a glass-enclosed bleed fountain where its quality can be judged at a glance without hazard from vapors. Desalted crude is discharged from the top of the desalter.

The standard desalting unit is a cylindrical pressure tank 10 ft. in diameter by 12 ft. on the straight side. Set up vertically, the tanks are from 17 to 23 ft. over-all in height. Any number of the standard units can be installed as a battery. High capacity units with throughput capacities up to 50,000 bbl. per day are also in extensive use. These electrospheres consist of a spherical tank from 22 to 36 ft. in diameter.

Electric-power control is maintained by individual switch panels operating at either 220 or 440 volts. Automatic switches cut the electric power if the liquid level should be lowered. Relief valves provide protection against excess pressures. A current-limiting device protects the electric equipment. Electrical fittings are in explosionproof housings.

Crudes are being desalted which contain as much as 1,100 lb. of salt per thousand barrels of oil, down to as low as 10 to 15 lb. Reduction of salts varies, usually averaging somewhere from 87 to 99 per cent, with an accompanying reduction of corrosive substances. Also removed are such solid materials as sand, volcanic ash, drilling mud, and rust.

This process is licensed by Petroleum Rectifying Co.



Constantly Mounting Demands Point to Average Runs in 1948 of 5,425,000 Bbl.

by John C. Casper

THE high level of refinery activity in 1948 is indicated by the new records in total crude runs to stills. In the first few months of the year the volume of crude processed at refineries has averaged about 12 per cent more than in the first quarter of 1947 and about 6.5 per cent more than the average for the past year. This is a continuation of the upward trend of 1947 when refiners ran a total of 1,852,246,000 bbl. of crude for an average of 5,075,000 bbl. daily or a gain of 7.1 per cent over 1946. If there are no serious breaks in refinery operations for the remaining quarters of the year, crude runs should average about 5,425,000 bbl. per day for 1948.

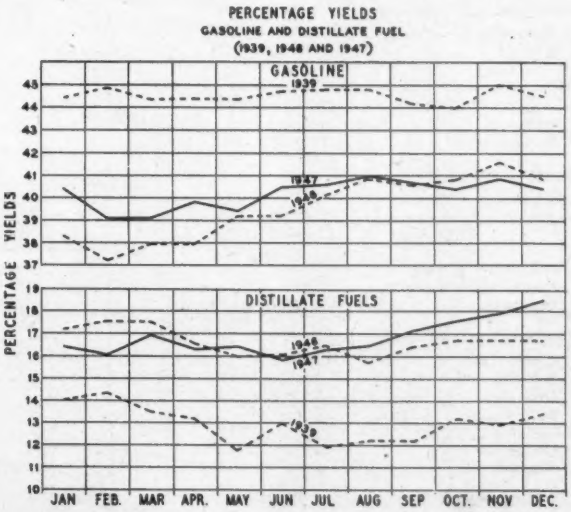
A breakdown of refinery runs by areas shows that three of the Bureau of Mines' districts—East Coast, Texas Gulf, and Louisiana Gulf—reported 47.2 per cent of total crude runs for 1947. These districts supply most of the products for the high demand areas in the eastern states. California accounted for 16.3 per cent of total runs, and the refineries of the other districts used the remaining 36.5 per cent.

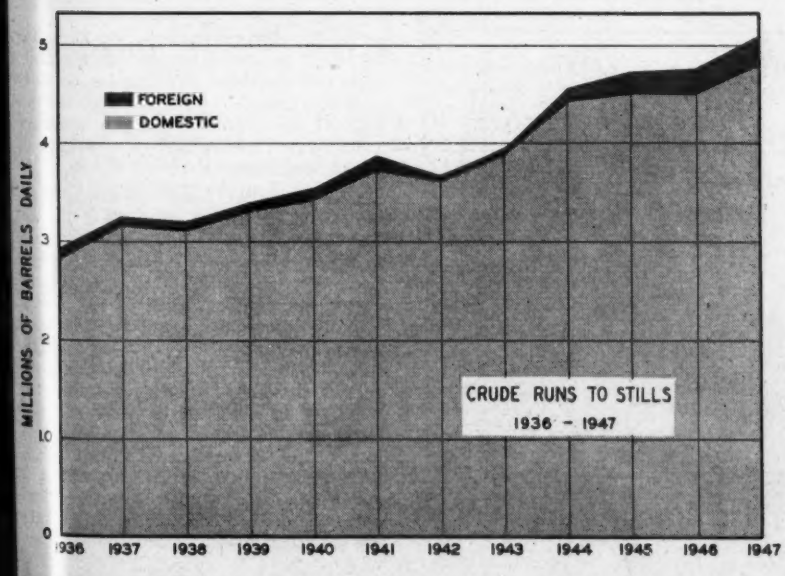
The monthly distribution of crude runs in 1947 followed the pattern of high product demand that developed after the first quarter of the year. Runs did not reach 5 million barrels per day until June, but climbed in the last half to an average of 5,350,000 bbl. per day for December.

The domestic and export deliveries of all products in 1947 rose to the record-setting average of 5,899,816 bbl. daily for a 10.7 per cent increase over 1946. This expansion was met by an increase of 7.0 per cent in crude production, a 14.1 per cent gain in the output at natural-gasoline and cycling plants, an increase of 15.9 per cent in imports, and a reduction of stocks amounting to 13,811 bbl. per day.

CRUDE RUNS TO STILLS BY DISTRICTS
(Thousands of barrels daily)

				Increases 1947 over	
	1947	1946	1940	1946	1940
East Coast	815	758	559	57	256
Appalachian	165	153	132	12	33
Ind.-Ill., etc.	826	767	617	59	209
Okla.-Kans., etc.	419	379	314	40	105
Texas Inland	232	216	169	16	63
Texas Gulf	1,197	1,163	923	34	274
Louisiana Gulf	384	332	123	52	261
Ark.-La. Inland	68	60	68	8	....
Rocky Mountain	143	131	82	12	61
California	826	781	549	45	277
Total United States*	5,075	4,740	3,536	335	1,539
*Foreign crude included	266	231	114	35	152





The outstanding increases in the major-products group were the gains of 22.8 per cent in deliveries of distillate fuel oil for domestic use, and 15.1 per cent in domestic kerosine consumption. The increases in demands for gasoline and heavy fuel were both about 8 per cent.

The large gain in the deliveries of middle distillates was the principal factor causing the jump in total demand in the fourth quarter to a point where the daily average was 7.6 per cent above the average for the year, but even the demand for gasoline was greater in December than in November. So the high level of demand in the last quarter resulted from a general buildup of consumer needs throughout the year plus a continua-

tion of the shift in seasonal requirements that started before the war. In 1934 only 48.4 per cent of total demand came in the first and fourth or winter quarters of the year while 51.6 per cent of the total was credited to the spring and summer quarters (second and third). The winter portion had passed the 50 per cent mark in 1938 and in 1940 was up to 51.2 per cent. Nothing can be learned about trends from the erratic demands during the war years, but in the first full post-war year of 1946 the winter deliveries still remained at the 1940 level of 51.2 per cent. The winter-season gains in 1947 moved the figure up to 52 per cent.

DEMAND AND SUPPLY OF PETROLEUM PRODUCTS
(Barrels daily)

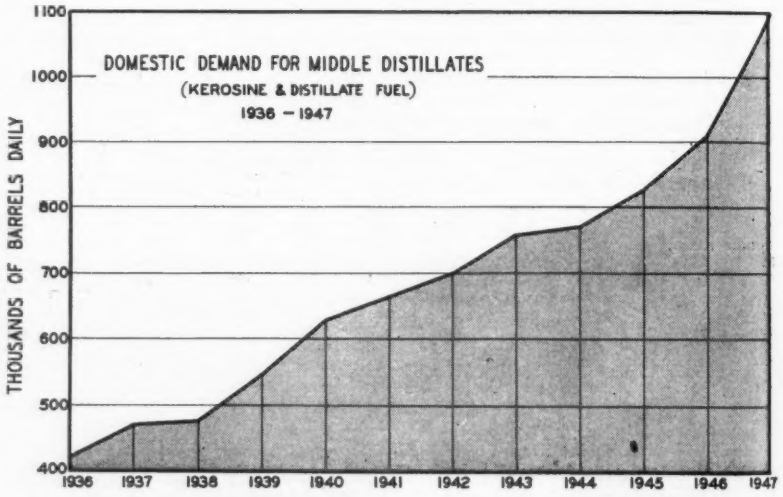
	1947	Per cent increase over 1946
Motor fuel demand	2,307,813	7.9
Domestic	2,177,553	8.1
Export	130,260	4.9
Kerosine demand	300,742	12.3
Domestic	280,841	15.1
Export	19,901	—15.9
Distillate fuel demand	899,041	20.5
Domestic	817,044	22.8
Export	81,997	1.5
Residual fuel demand	1,449,696	8.2
Domestic	1,420,258	8.0
Export	29,438	16.9
Other demands and losses	942,524	12.5
Domestic	753,537	12.1
Export (inc. crude)	188,987	14.1
Total demand	5,899,816	10.7
Domestic	5,449,233	10.9
Export: Crude	126,348	8.7
Products	324,235	6.9
Total stock change	—13,811	...
Crude oil	+1,310	...
Products	—15,121	...
Domestic production	5,448,759	7.4
Crude oil	5,085,225	7.0
Natural gasoline, etc.	361,644	14.1
Benzol	1,890	—66.7
Imports	437,246	15.9
Crude oil	267,211	13.3
Products	170,035	20.3
Total new supply	5,886,005	8.0
Crude runs to still	5,074,647	7.1

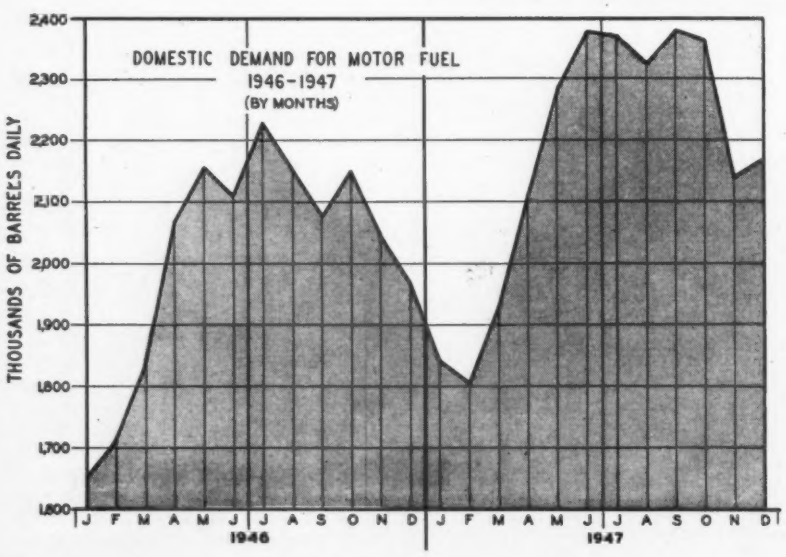
DIVISION OF TOTAL DOMESTIC DEMAND INTO SUMMER AND WINTER DELIVERIES

	Per cent of domestic demand	
	1st and 4th quarters	2nd and 3rd quarters
1934	48.4	51.6
1935	49.6	50.4
1936	49.4	50.6
1937	49.1	50.9
1938	50.3	49.7
1939	50.4	49.6
1940	51.2	48.8
War Years		
1946	51.2	48.8
1947	52.0	48.0

By the end of 1947, the potential demand for petroleum products had reached the point where refinery capacity was one of the major limiting factors in the process of satisfying this demand. Since refineries were being operated at or near capacity and still were unable to supply all of the needed middle distillates, a gradual shift of the yield pattern took place. Production of distillate fuel in December represented a yield of 18.5 per cent, and current reports indicate that the figures for January and February have been as high as 20 per cent.

This problem of a high ratio of demand to refinery capacity will continue throughout 1948. Gasoline inventories have been built up during the past heating season to a point where the finished and unfinished stocks are about 7 million barrels above a year ago. Preliminary data for the first few months of 1948 indicate that gasoline deliveries are about 4 or 5 per cent above the first quarter of 1947, but the 12 per cent increase in crude runs has made possible this stock accumulation even with low percentage yields of gasoline. However, the heavy motor-fuel demands of the second and third quarters will reduce these inventories to normal working levels, even after allowing for the summer gasoline production from refineries operating at maximum rates.





On the other hand, if crude runs can be maintained at about 5,425,000 bbl. per day for the second and third quarters with a near-normal yield pattern, distillate stocks should be raised, perhaps as much as 10 million barrels, above the level that existed at the opening of the 1947-48 heating season. An additional 10 million barrels of distillate stocks, available for delivery in December, January, and February, might make it possible to lower the percentage distillate yield for the 3-month period by about 2 per cent. This would give a yield pattern more like the normal operating practices of past years.

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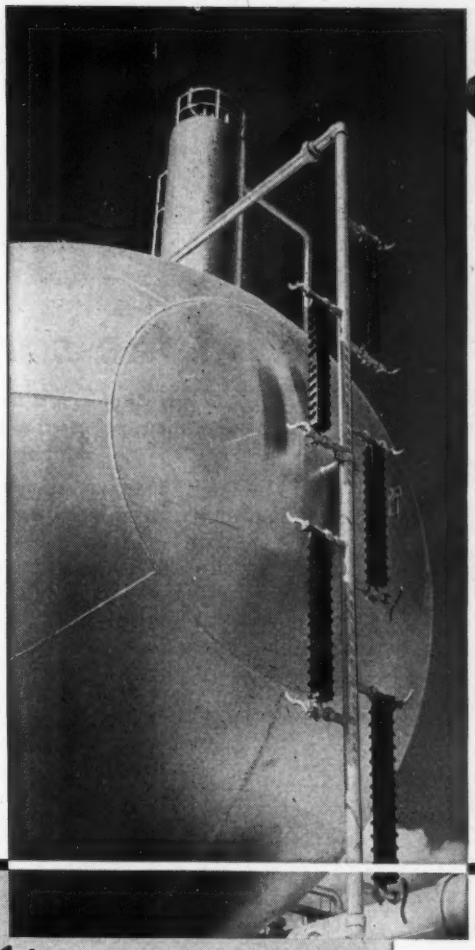

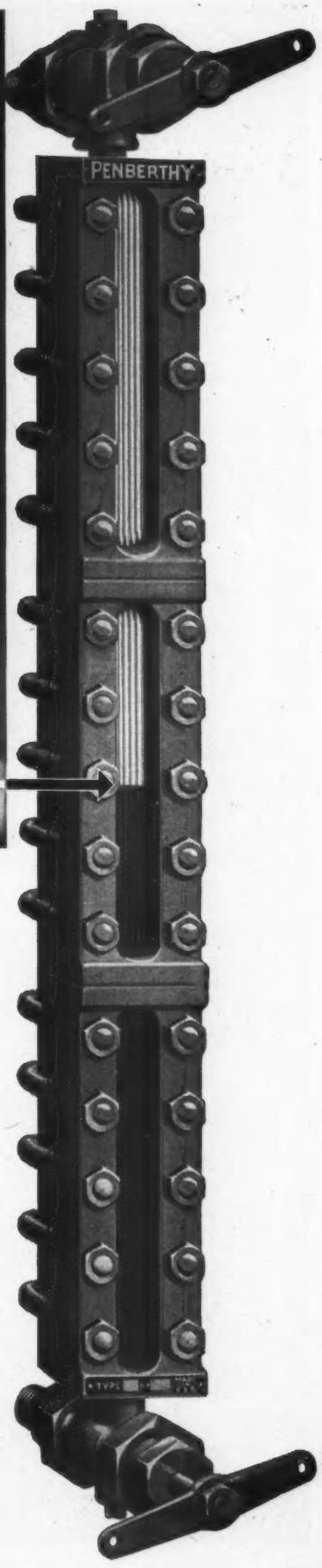

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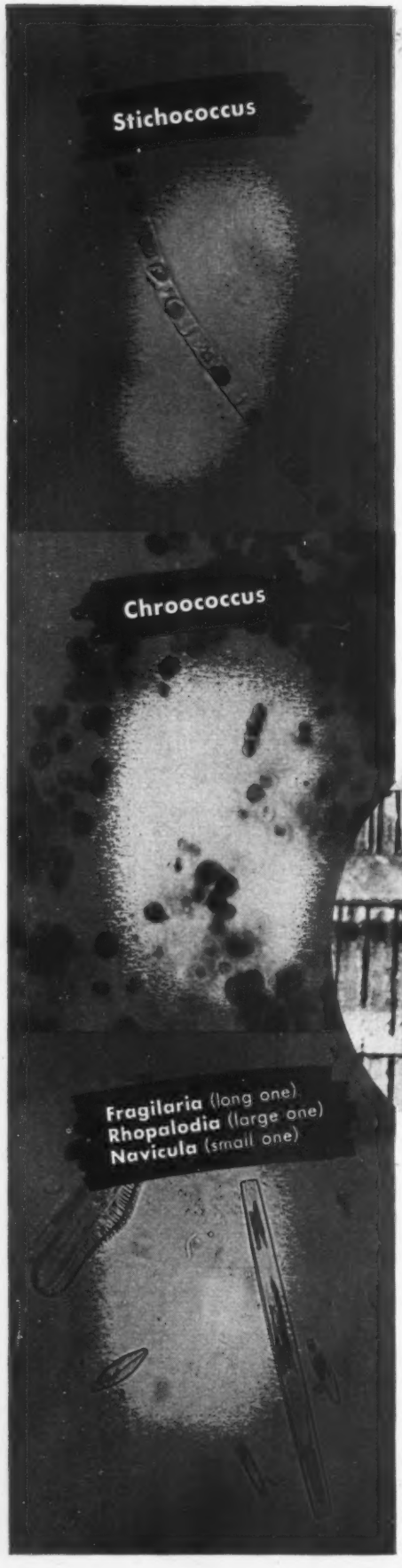

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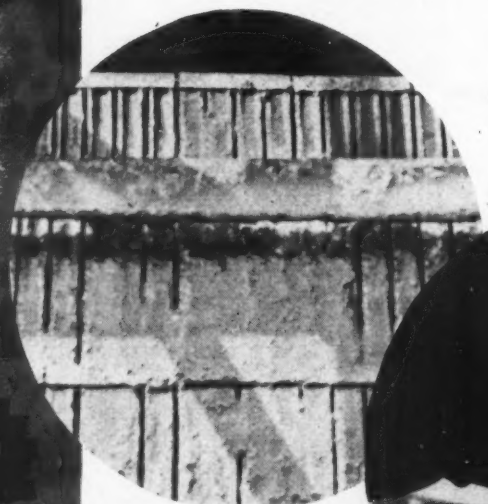

Left — Showing Algae Growth in Cooling Tower.

Right — View in the Nalco Bacteriological Laboratory, Part of the World's Finest Water Treatment Laboratories.

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Chemical Treatment of Fractions From Gulf Coast Naphthenic-Base Crude

for production of lubricating oils

by R. I. Jacobi* and L. E. McMakin*

FOR many years one of the major refineries on the Gulf Coast has been producing lubricating oils ranging in S.S.U, viscosity from 60 at 100° F. to as high as 150 to 200 at 210° F., from naphthenic crude obtained in that area. The finished oils are characterized by low pour; low viscosity index; low carbon residue, which is soft in nature; and good color properties.

The crude itself runs about 24.0° A.P.I., 0.25 per cent sulfur, and is dark green in color. The acid number on this material, however, ranges from 1.0 to 2.0, and this necessitates injection of caustic during the distillation step in order to minimize equipment corrosion and to produce low-acid-number distillates for treating. The soaps thus formed leave the distillation system in the residuum which is ultimately disposed of in a coking process.

The distillation unit consists of both atmospheric and vacuum side cuts and has a small shell-still preheat system which also serves to remove the small quantity of gasoline obtained from this crude. The capacity of the unit is approximately 15,000 bbl. per stream day of crude charge. Crude is charged through the shell-still preheat system where 5 per cent of gasoline or naphtha is removed. From this point the preheated crude flows to the atmospheric side of the main unit from which some 45 per cent of gas oil, which is used as catalytic cracking charge, is removed. Following the gas oil cut five subsequent side streams are taken on the atmospheric and vacuum fractionators, the combined yields of which amount of 40 per cent of crude-oil charge. The vacuum bottoms amounting to 10 per cent of the crude-oil charge are disposed of, as mentioned above, by coking.

In Table 1, under the heading of distillates are tabulated the tests on the five lube-distillate side-stream cuts. In the case of the dilution distillates, however, it should be ex-

(Continued on page 233)

TABLE 1—LUBE DISTILLATES AND FINISHED OILS FROM COASTAL CRUDE

Distillate:	55-60	100	300	1,200	Dilution*
Vis. S.S.U.	55/100	109/100	310/100	80/210	260/100
Flash	280	310	370	445	315
Treatment:					
Lb. 98% acid per bbl. oil	10	15	25	30	40
Lb. soda ash per bbl. oil	1	1.5	2.0	2.5	3.0
Finished oil:	55-60 pale	100 pale	300 pale	1,200 pale	2,000 pale
Viscosity	56/100	105/100	305/100	72/210	100/210
Flash	280	310	370	445	475
Color	1½+	1½+	2+	3+	3½—
Pour, °F.	—65	—45	—25	—5	20
Acid No.	0.03	0.03	0.03	0.03	0.03
Con. carb. res.	0.01	0.03	0.04	0.08	0.28

TABLE 2—FINISHED OILS PRODUCED BY BLENDING DISTILLATES BEFORE TREAT

Distillate treatment:	200	500	750
Lb. 98% acid per bbl. oil	20	25	30
Lb soda ash per bbl. oil	1.5	2.0	2.5
Finished oil:	200 pale	500 pale	750 pale
Flash	340	385	410
Viscosity	205/100	509/100	750/100
Color	2+	2+	3—
Pour, °F.	—30	—10	—10
Acid No.	0.03	0.03	0.03
Con. carb. res.	0.02	0.05	0.07

*Heavy lube distillate (150/210 S.S.U.) after cutting back with 100 vis. stock preparatory to treating.

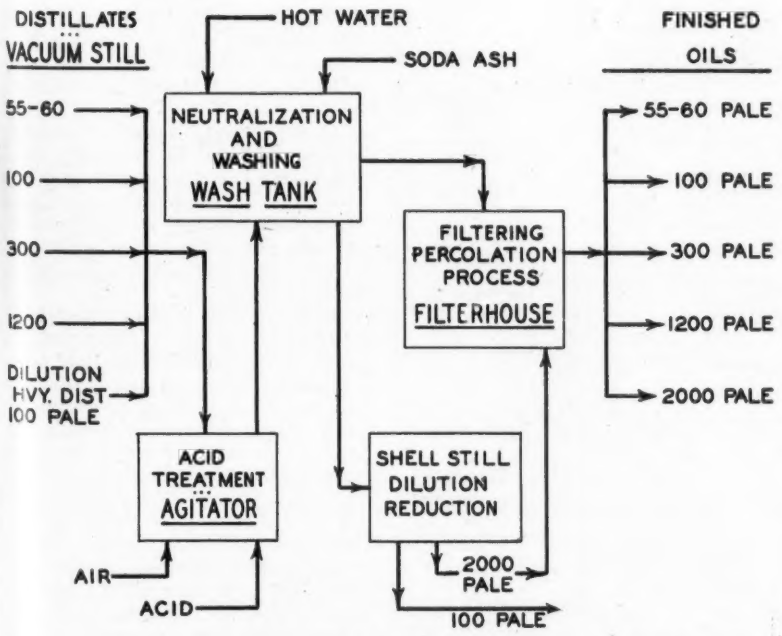


Fig. 1—Flow chart for manufacture of low-pour, low-carbon-residue lubricants from South Texas crude

*Sinclair Refining Co.

Processing West Texas Crude

*by W. K. Jackson**

THE Cosden refinery operates entirely on sour West Texas crude, and has a designed capacity of 15,000 bbl. per calendar day, although current intake is somewhat higher. This refinery has never processed other than sour West Texas crude, and therefore, maintenance and operating problems have always involved this type of crude.

The points at which corrosion is most severe are (1) in furnace tubes, transfer lines and (2) in gasoline condensers. The means taken to combat corrosion at these points are desalting, lime injection, and selection of corrosion-resistant metal.

Although our 20-month-old desalters are effective in reducing salt content to 5 lb. per 1,000 bbl. from an average of 40, and although the desalter undoubtedly aids in attaining long cracking-plant runs, it apparently has little or no effect on suppressing corrosion of heater tubes or gasoline-condensate equipment. Lime injection has a most beneficient effect on heater-tube life and is considered indispensable at this refinery. Yet lime injection exerts no apparent effect in retarding corrosion in the gasoline-condensate systems. Use of admiralty bronze and cast iron for gasoline condensers and condensate lines to the accumulators, and cast iron or Ni-Resist for pump impellers and valve trims on the reflux system is eminently satisfactory. Our practical experience on the various units will best serve to illustrate these points.

*Technologist, Cosden Petroleum Corp., Big Spring, Tex.

Topping Unit

Five years ago the topping plant comprised two almost identical units, each consisting of a heater, a flash tower, and a fractionator. The heaters had carbon-steel tubes. The condensers were submerged bundles of 1¼-in. phosphorized admiralty brass tubes with cast iron headers. The condensate lines and reflux accumulators were carbon steel. There were no crude desalters, and the salt content varied from 35 to 100 lb. per 1,000 bbl. depending upon season of the year and residence time in the crude tanks. One-eighth pound of lime per barrel was injected into the crude stream entering the heaters. Average life of 4-in. o.d. ½-in. wall-thickness tubes was 2 years in the radiant section and 4 years in the convection section.

No corrosion whatsoever was evident in the admiralty condenser tubes, and only very slight corrosion in the cast-iron heads. These condensers have been in the same service for more than 10 years. The horizontal sections of the condensate lines from the condenser to the reflux accumulator, on the other hand, had been known to corrode completely through and leak in as short a time as a week, although usually they would last about a month. The carbon-steel accumulators corroded rapidly below the water interface. The reflux pumps and control valves were cast iron and showed little corrosion. Attempts at protecting the condensate lines with various plastic-coating materials were unsuccessful.

The lesson seemed to be that admiralty and cast iron resisted corrosion of condensing gasoline containing moisture, H_2S, and traces of HCl. The one exception was the vapor-to-crude exchanger which had admiralty tubes and a cast-iron shell. It gave trouble on the vapor side by corrosion of the shell, although the admiralty tubes were unaffected. Experience with this exchanger may be misleading since it was over 15 years old.

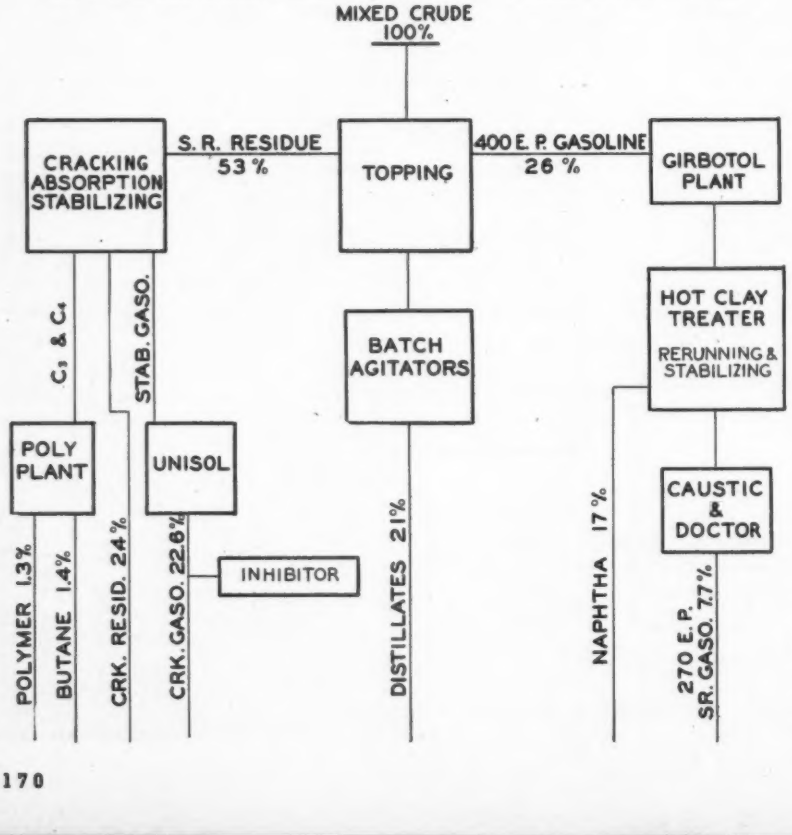
Change to Present Operations

Two years ago the topping plant was revamped and the two old heaters replaced with a single but more efficient new, larger, and modern heater.

At present the mixed crude, after being preheated by exchange with condensing overhead vapors and then by residue, is charged through a bank of Petreco desalters directly into the primary crude fractionator. One coil in a two-coil heater acts as a reboiler for this tower.

Approximately half of the gasoline is removed in the six-tray primary tower, but no distillate cuts are taken here. Bottoms from this tower are pumped through the other coil in the heater to a flash drum which separates the straightrun residue and thence into the secondary crude fractionator. Here the remaining gasoline (up to 400° e.p.) is removed and all the distillate cuts are made. The vapor-to-crude exchanger is in the overhead line from this column and the residue-to-crude exchangers in the bottom line from the flash drum. Average properties of the crude and products are shown in Tables 1 and 2.

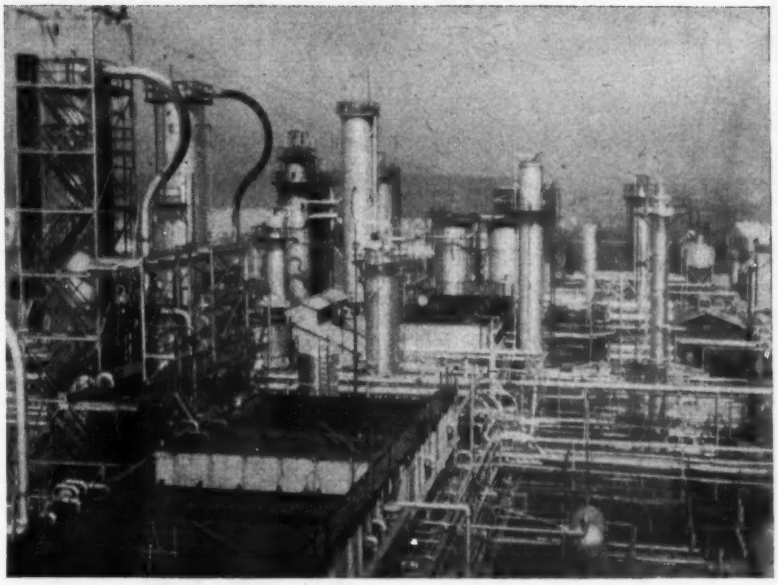
PROCESS ROUTES AND PRODUCT YIELDS FOLLOWED BY COSDEN PETROLEUM CORP., CHARGING WEST TEXAS SOUR CRUDE



and typical operating pressures and temperatures are shown in Table 3:

The two-topping-column arrangement is necessary because none of the plants' available columns were large enough to handle the entire vapor load. Furthermore, using one of the two coils in the heater as a fired reboiler, and thus causing the primary column to double as a dehydrator, was supposed to eliminate or suppress corrosion in the carbon-steel heater tubes.

When the unit went on stream, the desalters had not yet been installed, so the customary lime injection was continued. However, through an oversight only about 1/20 lb. of lime per barrel of crude was added instead of ⅛ lb. per barrel as had been customary on the old unit. In 16 weeks one of the radiant tubes failed and the rest were found dangerously thin. Because 4-6 per cent chrome tubes could be delivered almost immediately as against almost indefinite delivery on steel tubes, the chrome was ordered.



View of Cosden's topping unit and processing section. Running entirely on sour crude, currently it is charging somewhat over its design capacity of 15,000 bbl. per day

TABLE 1—LABORATORY ANALYSIS OF CRUDE OIL

	15,000 to 18,000 bbl. per day		
	Howard-Glasscock	East Howard	Yoakum
Per cent of total refinery charge	68	14	18
Gravity A.P.I. at 60° F.	29.6	29.5	32.5
400 e.p. gasoline content, per cent volume	21.4	31.4	32.2
Kerosine	14.8	13.8	12.1
Gas oil	24.8	20.4	15.5
Residue	38.0	33.4	39.2
Total sulfur, per cent weight	1.6	1.6	1.8

TABLE 2—AVERAGE PROPERTIES OF PRODUCTS

	Straightrun gasoline			Cracked gasoline		Distillates			
	Before clay	After clay	Polymer	Before Unisol	After Unisol	Diesel	No. 1 fuel	No. 2 fuel	No. 3 fuel
Gravity	57.3	57.2	64	55.6	55.6	34-37	38-40	35-37	33-35
I.b.p.	98	96	112	110	110	380-400	340-360	370-390	390-410
10 per cent	160	162	175	148	148	430-440	380-400	420-440	450-470
50 per cent	252	250	220	255	255	500-520	440-450	490-510	540-560
90 per cent	346	340	326	352	352	600-610	490-510	590-600	650-675
End point	396	396	416	395	395	*675	540-560	630-650	*725
R.v.p.	5.5	5.5	5.0	3.9	3.9	.....	.....	.....	.....
Sulfur total, per cent	.187	0.3	.3	.24	.17	*0.7	*0.5	*0.7	*0.75
Sulfur mercaptan, per cent	.078	.0	.03	.09	.002	.....	.....	.....	.....
Oct. A.S.T.M.	58.5	59.6	80.8	69.5	70.5	.....	.....	.....	.....
Oct. 3 cc. TEL	72.4	78.2	84.0	77	78.5	.....	.....	.....	.....
Oct. research	...	...	97.6	...	78.8	.....	.....	.....	.....
Oct. research +3 cc. TEL	...	...	99.3	...	87.6	.....	.....	.....	.....
Pour, °F.	...	...	...	...	...	0	—25	—0	+10
Color	...	...	...	...	...	2½	1½	2½	3
Vis. S.U. at 100° F.	...	...	...	...	...	35-40	35	35-40	35-40
Carbon max. (10% bttms.)	...	...	...	...	...	0.20	0.12	0.20	0.20
Corrosion	...	...	...	...	...	O.K.	O.K.	O.K.	O.K.
Flash cc. max., °F.	...	...	...	...	...	150	130	130	130
Cetane	...	...	...	...	...	48-50	45+	45+	45+

*Maximum.

TABLE 3—TYPICAL OPERATING CONDITIONS—COSDEN'S CRUDE UNIT

	No. 1 column	Flash drum	No. 2 column
Pressure, psi.	20	16	14
Inlet temperature, °F.	315	...	3
Top temperature, °F.	282	600	336
Bottom temperature, °F.	435	600	...

Reboiler coil inlet pressure, 88 psi.; outlet temperature, 620° F.
Flash-drum preheating-coil inlet pressure 88 psi.; outlet temperature, 620° F.

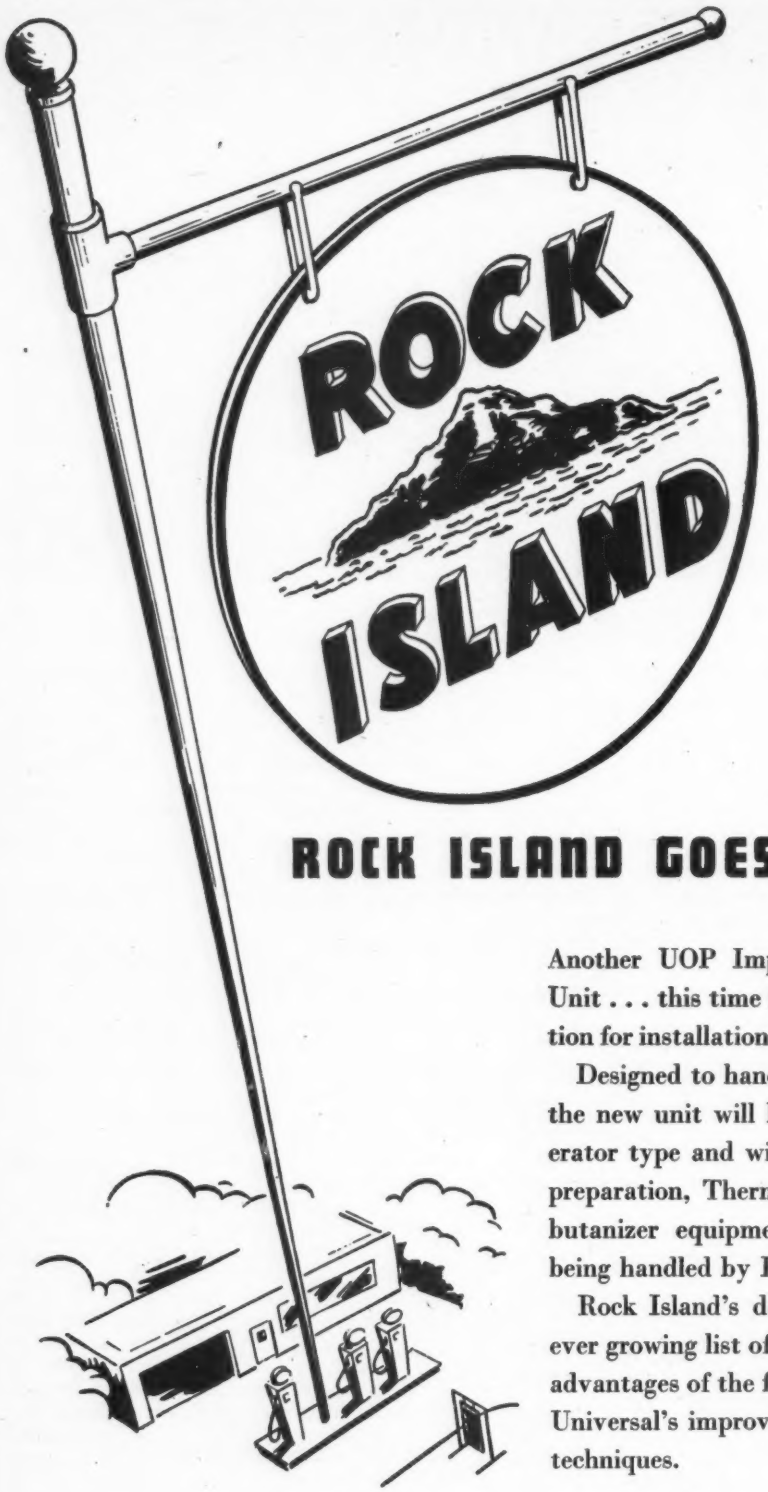
Shortly before delivery and installation of the chrome tubes, the desalters were completed, and when the new tubes were in place, lime injection was discontinued in the mistaken belief that crude desalting plus the expensive alloy would eliminate corrosion in the furnace. Thirteen months later it was necessary to replace many of the chrome tubes because they, too, had become thin.

Now 1/10 to 1/8 lb. of lime per barrel of crude is injected just after the desalter and it is believed that tube life will exceed 2 years. The old unit gave an average of 2 years on steel tubes when there was no desalting and no dehydrating, but plenty of lime.

During the revamp, the rundown lines from the condensers to the two reflux accumulators were replaced with cast iron. In over 2 years there is only light evidence of corrosion and then only on the bottom of horizontal sections. The effect is minimized by rotating these sections a couple of bolt holes every 4 or 6 month. The admiralty condensers and their cast-iron heads still give evidence of lasting forever. The vapor-to crude exchanger has recently been replaced with another having admiralty tubes and a naval bronze shell liner installed inside the carbon-steel shell by the refinery welders. Time will determine the effectiveness of this measure.

Corrosion of the steel reflux accumulators is minimized by injection of spent caustic to maintain the pH of the water on the alkaline side. This is not too satisfactory since, on one occasion, failure to keep the water level below reflux suction resulted in plugging of the top tray on

(Continued on page 235)



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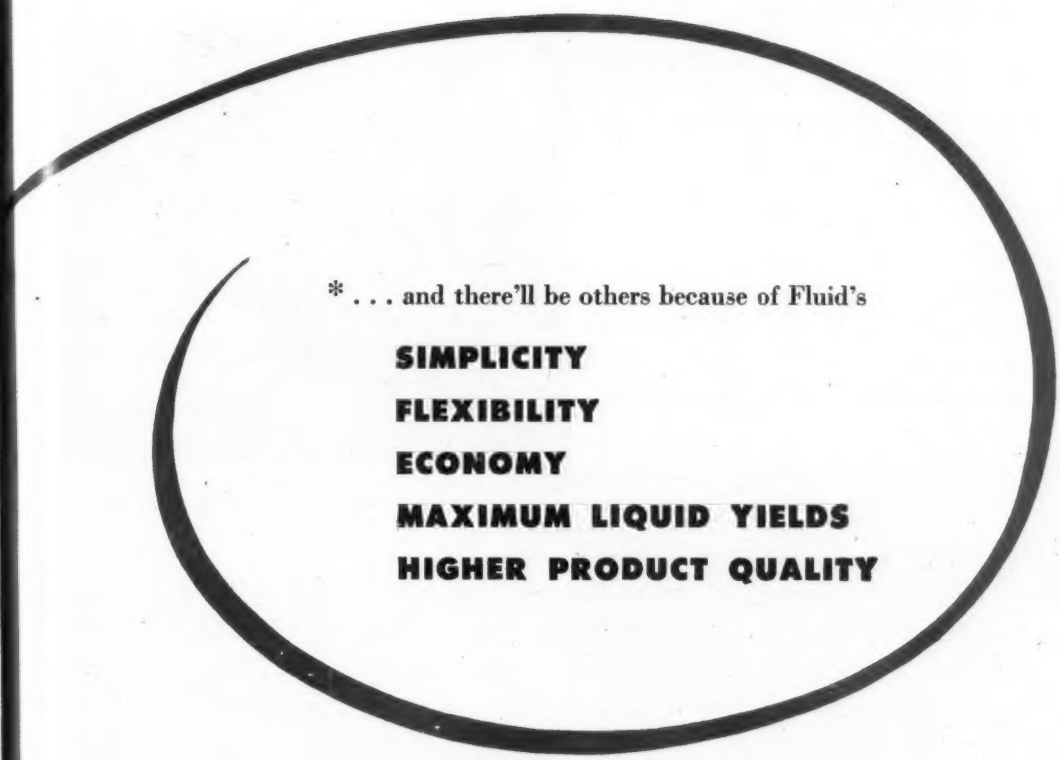
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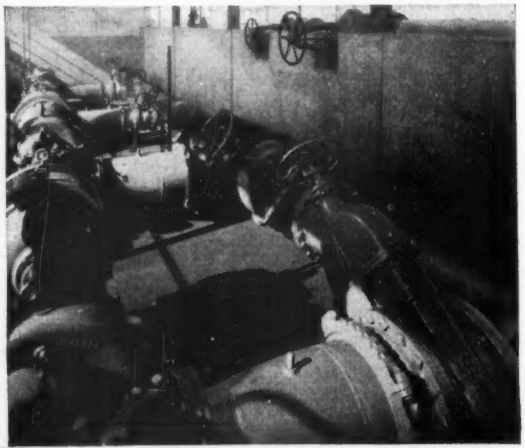
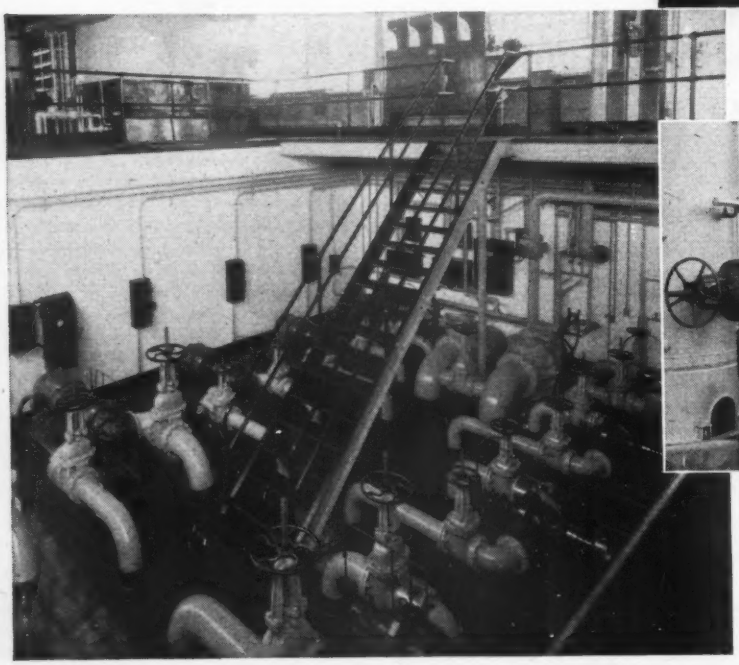
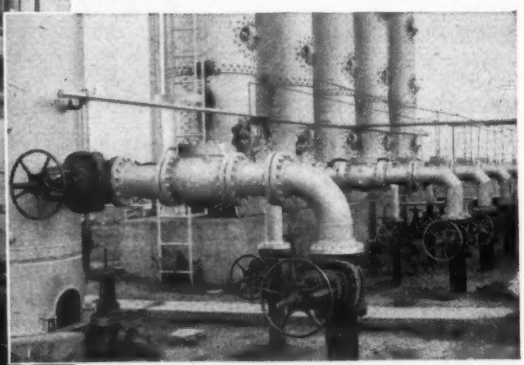


PUMP PIT *in cooling tower of large cycling plant using Crane 24-in. low pressure gate valves in water lines.*





ABSORBER UNIT *in dehydrating plant showing Crane 125 and 250-pound flanged iron check and gate valves, and welding materials in 8 and 12-in. lines.*

GAS COMPRESSOR STATION *cooling water pumps equipped with Crane wedge disc and double disc gate valves. Also flanged and welding fittings from the complete Crane line.*

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Bell Refinery Makes Unusual Installation To Profit From Vapor Recovery

by I. A. Anson and Rudell Russell†*

ALL refineries start out by being built "new from the ground up." But equally important are the constant and continuing demands for good planning and engineering in recurrent revamping and remodeling programs necessary to keep producing efficiently the products that may be involved in changing processing situations and in meeting new market requirements. This revamping and remodeling is a continuous "must" both as to the large plants, the medium-size ones, and the small units.

Many different courses may be indicated in revising and expanding the equipment and processing existing in a given refinery. This article describes the new processing which was effected by purchasing a poly and codimer unit that was being dismantled by Refinery Engineering Co. of Tulsa, in Michigan. These units were installed in a preplanned program at the Granfield, Okla., refinery of Bell Oil & Gas Co. The completed program afforded (1) provision to stabilize pressure distillate, (2) caustic treatment of the overhead from the P.D. stabilizer, (3) processing of the material through a catalytic polymerization unit to produce (4) a poly butane mixture and (5) commercial propane for L.P.G. sales.

The installation was made by unitizing the poly plant integrally with an existing stabilizing unit. A noteworthy feature of the installation and design is the use of the old stabilizing unit column as a deethanizer. This arrangement made easy the building of an L.P.G. unit for the manufacture of commercial propane so that both the poly and L.P.G. units could be constructed at once without the erection of a separate deethanizer tower. Aside from the crowded space the construction was limited to, the effective use of the existing stabilizing unit tower as a deethanizer (C) made it possible to proceed with economy and speed and to assure simplicity in operation.

The old column was a combination stabilizer and absorber. Before the installation of the poly and L.P.G. units the column was operated in such a manner as to withdraw all C_3 and lighter overhead together with a considerable quantity of C_4. Since there was a limit to the amount of C_4 that could be tolerated in the finished gasoline especially in the summer when the gasoline is held down to 10 lb. R.v.p., it was necessary to lose a considerable quantity of C_4 via the overhead of the combination column to fuel gas. During the war the tower was operated so as to withdraw a larger quantity of C_4 from the bottom in order to make a B-B product for shipment to the Associated Refinery at Duncan, Okla., for use in the manufacture of 100-octane aviation gasoline.

The new design in connection with the poly and L.P.G. units calls for withdrawal of maximum quantities of C_3 and heavier from the bottom of tower (C) so that only C_2 and lighter should go overhead to fuel gas. This design has proved effectual and this is the chief report of this article. The remainder of the report describes the conventional hookup as illustrated in the flow sheet and photograph.

Process Arrangement

The 18 to 20-lb. R.v.p. gas plus uncondensed gasses off the Dubbs condensers are separated in the P.D. receiver. The gases are charged by a 100-hp. two-cycle gas-engine-direct-driven compressor through a water cooler into the column (C) under the blind tray which separates the stabilizer section from the absorber. Here the heavier gases that were liquefied on compression go to the stabilizer section and the lighter gases go through the side cooler into the top absorber section of the column. The 18 to 20-lb. R.v.p. P.D. in the bottom of the receiver is charged above the blind tray of the column. Here the lighter gases have a chance to rise in the absorber and the heavy gas descends through the downcomer into the stabilizer section. The pressure on this column is 140 psi.

The top temperature of 80° F. is not controlled but varies some 10° F. depending on weather conditions, but this variation seems to have little effect on the operation in general. This top temperature, however, is held to a minimum by lowering the temperature of the absorber oil to near the temperature of the cooling water. During cold weather, the absorber oil is between 70° and 80° F.

The absorber oil is 400° F. end point P.D. gasoline taken from the bottom of the butane separator (E) and charged to the stripper column (A), where it is stripped to 51° to 53° A.P.I. gravity and 0 R.v.p. The overhead light ends from this stripper are taken through a cooler into the P.D. stream to the treating plant. The bottoms are cooled to 70° to 80° F., and pumped through a flow meter-controller over the top of the absorber section, tower (C).

The middle temperature of 110° F. in column (C) also fluctuates some 10° F. which temperature can be kept in range by the temperature of the P.D. charge and the amount of water in the side cooler and gases. The bottom temperature of 270° F. is obtained and controlled with reboiler oil from the Dubbs fractionator. This bottom reboiler is connected for once-through operation. A downcomer on the bottom bubble deck admits the P.D. gasoline into the reboiler side of the tower bottom. A bisecting weir in the bottom of the tower carries a level with sufficient head to cause the gasoline to flow upward through the reboiler via the vapor line. It continues over into the opposite section of the tower bottom where the light ends are free to pass upward. A level control allows the deethanized gasoline to go into the butane separator column (E).

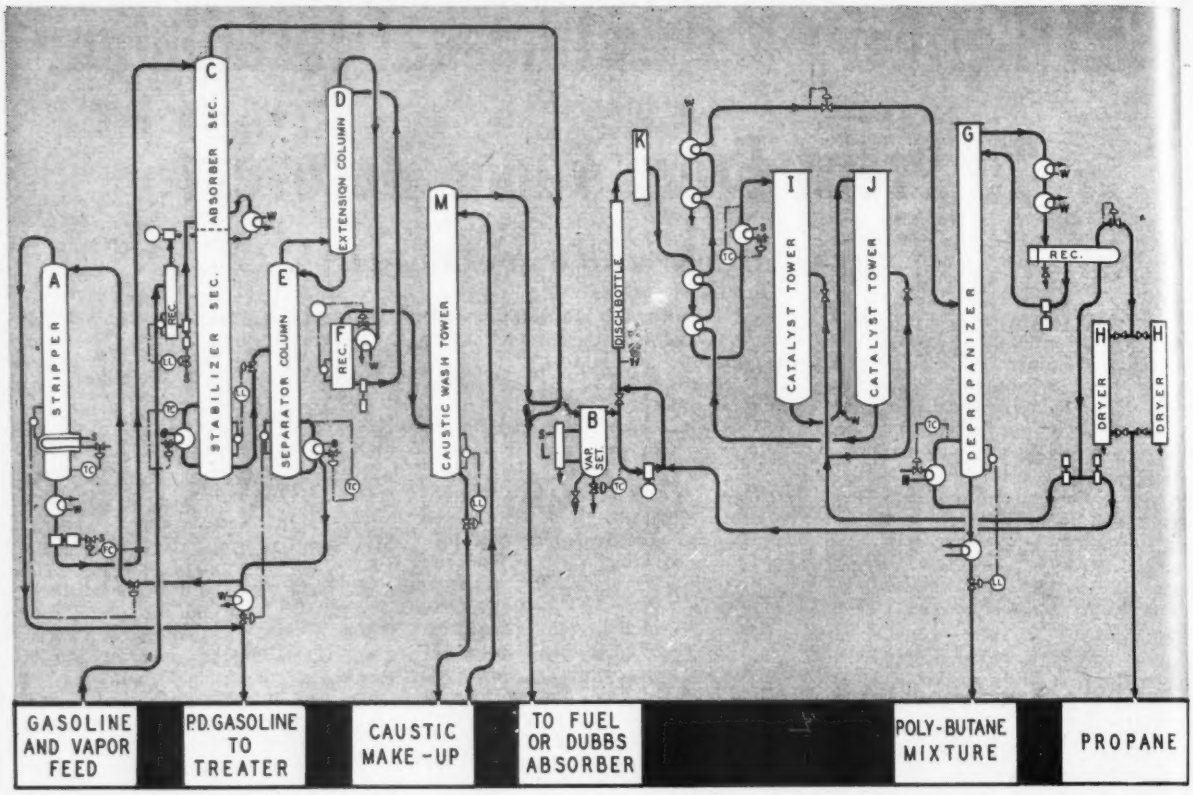
Increase in C_3

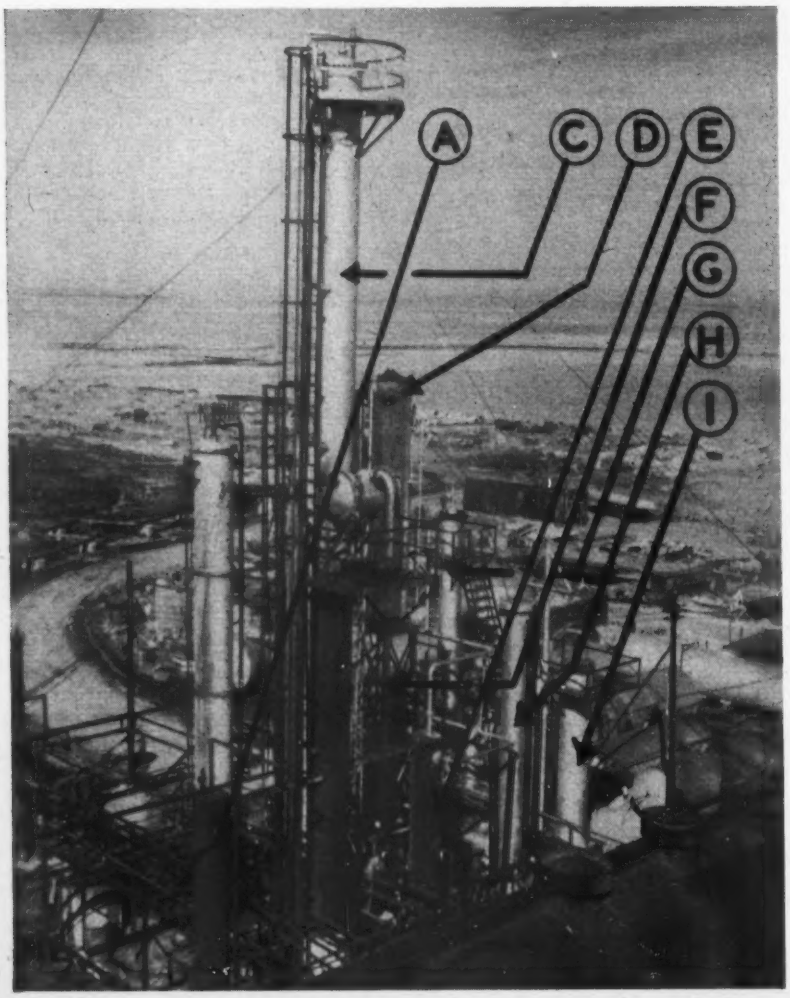
At this point the P.D. gasoline contains all the butane and as much propane as can be kept down into the bottoms by maximum absorber oil overhead and minimum bottom temperatures. The overhead gases of column (C) before the poly plant was added, contained 28.5 mol per cent propylene, 28.1 per cent propane, and 0.7 per cent C_4. As the unsaturates in this stream now average between 6 and 7 per cent, this stream now contains an estimated total of 15 per cent C_3 instead of the previous 56.6 per cent.

In the butane separator (E) and extension column (D) the amount of the C_3-C_4 fraction overhead is controlled by the bottom temperature, overhead reflux, and catalyst-charge compressor speed. All the C_3 is taken overhead and enough C_4 is left in the P.D. to make 10-lb. finished P.D. gasoline off the bottom of the separator column (E).

When making 10-lb. R.v.p. off the bottom, the overhead fraction is 78-lb. R.v.p. and is made up of approxi-

*Vice president and †engineer, Bell Oil & Gas Co., Tulsa.





Bell Oil & Gas Co.—Flow diagram and photograph (the letters E, F, G, etc., correspond for each). The chart shows how some of the equipment from a polymerization plant and from a codimer unit are employed to process pressure distillate. Arrangement of the various vessels in the refinery may be seen in the picture

mately 60 per cent C_3 and 40 per cent C_4, which amounts to 200 M.c.f. per day of gas charge to the poly plant. The liquid level control in the C_3-C_4 receiver (F) opens on high level and permits uncondensed gases to go overhead to caustic wash tower (M).

The control valve closes on a low level which causes the gas to pass through the condenser thereby raising the level in the receiver. Amount of the reflux over the extension column (D) is approximately 1,200 bbl. per day or a 1:1 ratio based on the column charge. This reflux is kept constant and the overhead make is controlled by the bottom tower temperature and the compressor speed. The gas off the top of the C_3-C_4 receiver (F) goes into the bottom of the countercurrent caustic wash tower (M) over which is pumped 1 g.p.m. of 8° Be caustic. This wash removes all traces of hydrogen sulfide and considerable mercaptan sulfur.

The gases from the top of the caustic wash column go to the vaporizer settler (B) where any caustic carryover is settled out and drained off to sewer. The settler has an ex-

(Continued on page 240)

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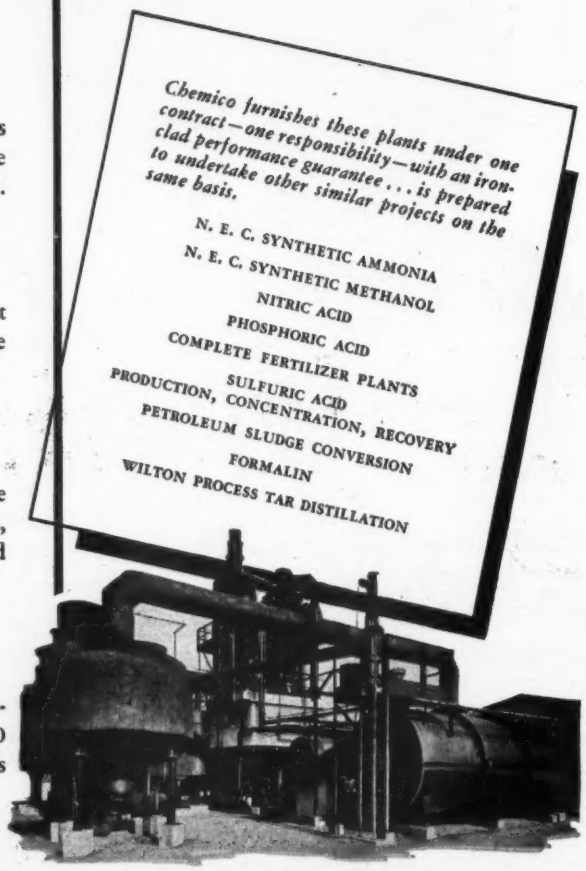
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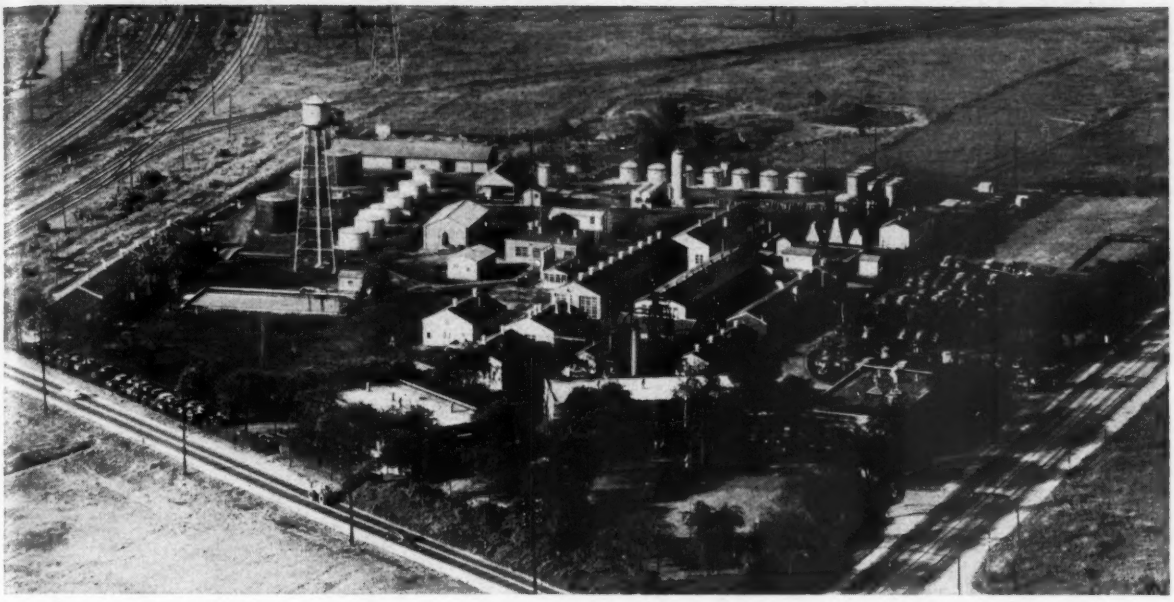
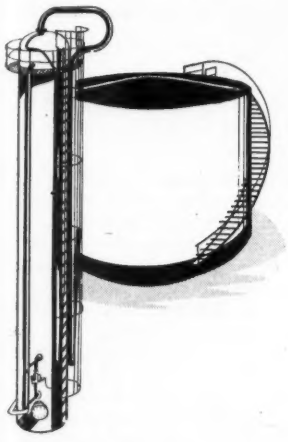


This spot—Universal Oil Products Co.'s Riverside laboratories, 10 miles southwest of Chicago's loop—is one of the world's nerve centers on refining and petrochemical development



PETROCHEMICALS

THE business of "petrochemistry" is advancing daily in its scope. Already it runs the gamut from producing stocks for face creams and lotions—through hundreds of useful synthetic organic compounds for manufacturing purposes—to detergents, special soaps, synthetic rubber, and even nylon. This article has been specially prepared to cover various current phases of this rapidly growing industry.

by Gustav Egloff*

PETROLEUM and natural gas furnished 3.5 billion pounds of raw materials for synthetic organic chemicals in 1946[22]. Of particular significance is the increase in proportion of chemicals produced from petroleum compared with other sources. Before 1940, petrochemicals accounted for less than 5 per cent of the total organic chemical production whereas 24.5 per cent was based on petroleum and natural gas in 1946. Although the skyrocketing growth came as a result of war emergencies, the petrochemical industry is now permanently established.

Hydrocarbons

The major portion of the raw materials obtained from petroleum and natural gas is hydrocarbons. These are produced from refining operations and by subsequent synthesis processes adapted to yield specific hydrocarbons. Large amounts of methane, ethane, propane, and the butanes are directly obtainable from natural gas, crude oil, and cracked products. Olefins are produced in quantity by cracking oils and paraffin gases. Liquid petroleum fractions are a source of paraffins through the octanes, cycloparaffins, and aromatics.

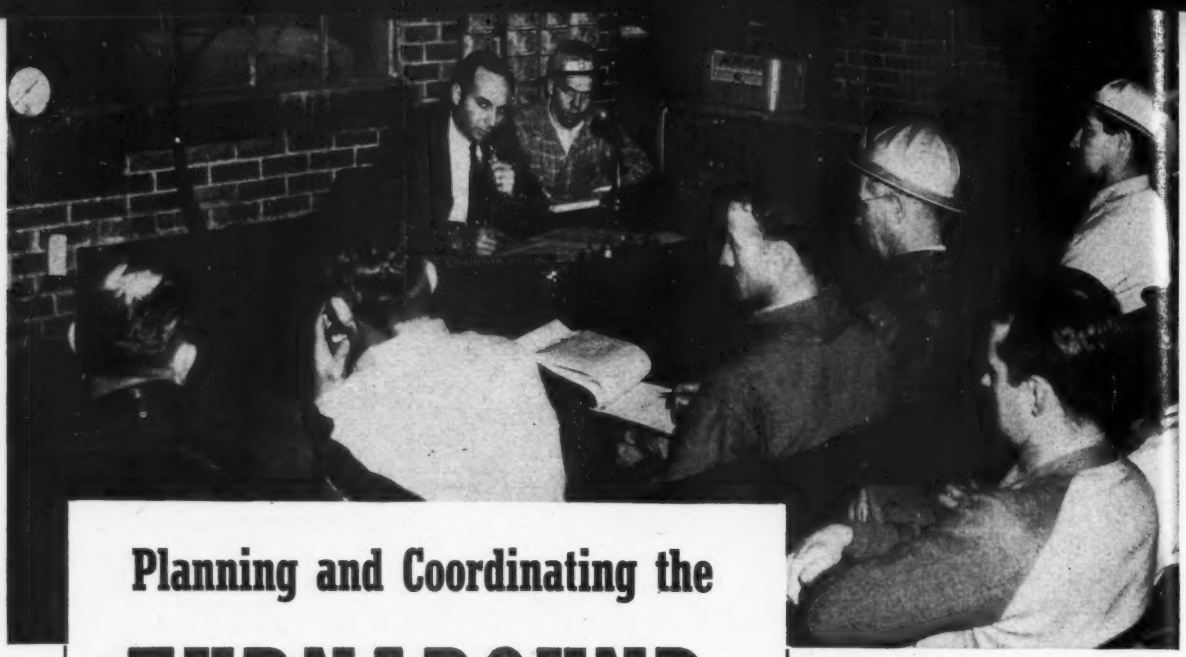
Among the highly important compounds produced from alkylation are 2,3-dimethylbutane, 2,2-dimethylbutane, 2,2,4-trimethylpentane, alkylbenzenes through C^{10} and alkylnaphthalenes. Dehydrogenation is used to make olefins, butadiene, pentadiene, and styrene. Conversely, hydrogenation makes possible the production of saturates from unsaturates. Polymerization is of particular consequence in the manufacture of chemicals such as polythene for resins and plastics, and butadiene-styrene copolymer for synthetic rubbers. Enormous quantities of aromatics are produced by hydroforming.

At the head of the list of hydrocarbons from petroleum is butadiene of which over a billion pounds were produced in 1946[23]. Although total production was somewhat less than 1945, when 470 million pounds were derived from alcohol, it is significant that the amount obtained from petroleum accounts for almost the entire 1946 production.

Ethylene is also high on the list of petroleum chemicals. Production in 1946 was 295 million pounds[22]. The known plant capacity in 1948 for manufacture of ethylene from natural gas is about 3.4 million pounds daily[15]. It is produced largely through cracking of ethane and propane gases. Two of the principal uses of ethylene are in the manufacture of alcohols

(Continued on page 246)

*Universal Oil Products Co., Chicago.



Planning and Coordinating the TURNAROUND At Esso's Baton Rouge Plant

Partial view of daily meeting held at turnaround headquarters by maintenance engineer with first-line craft supervisors. A small public address system, with portable microphone, is used to overcome extraneous noises

by A. J. Ferguson*

ONE hundred thousand dollars spent in 2 weeks. . . . That is the magnitude of cost involved in a turnaround of a large, modern refinery operating unit. At a large oil refinery, turnarounds at one operating unit or another are a regular part of the daily work routine. The magnitude and nature of this turnaround work are such as to provide a very fertile field for reduction of refinery maintenance costs.

A principal means of accomplishing such savings is through better planning and coordination of the turnaround work. As many as 400 men in 15 or 20 mechanical crafts are required to perform the work of a turnaround. In addition other groups such as the process department, mechanical engineering department, and the technical departments all have some part to play. Unless the efforts of all of these groups are carefully planned and coordinated, there are likely to be considerable duplications of work and inefficiencies of other sorts.

An integrated system of turnaround planning and coordination is presently being followed at Esso Standard's large Baton Rouge refinery. This system includes the following principal procedures:

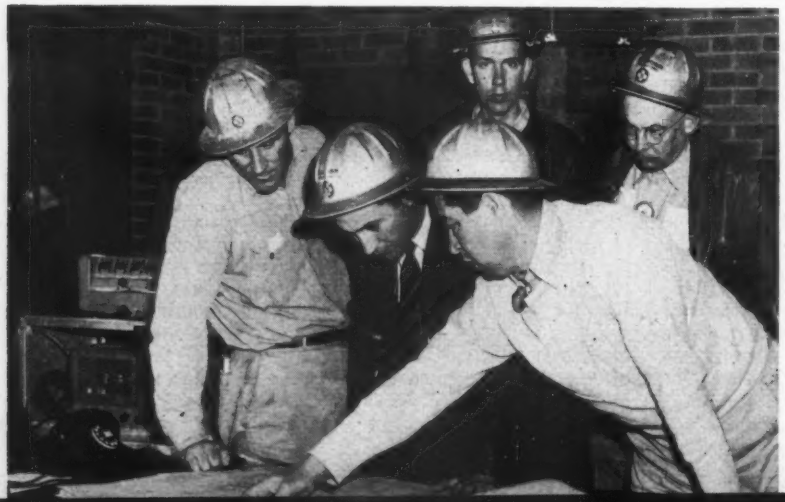
1. **Preliminary meeting with process department.**—A meeting is called at least 1 month before the scheduled start of the turnaround by the process department involved, with representatives being present from the process group, the maintenance and construction department, the mechanical engineering department, and any departments of the technical division that might have an interest in the work. In this meeting there is developed a list of the work to be done during the turnaround. This list is prepared in typed form and used as a basis for developing the job-planning sheets.

2. **Job-planning sheets.**—On these sheets are listed all items of work to be done during the turnaround, along with the manpower required and the order in which each phase of the job is to be undertaken. Material availability and any other significant considerations in connection with the work are also included. These planning sheets are prepared by the maintenance engineer approximately 2 weeks before the turnaround, who coordinates all mechanical work for the area in question, through consultation with the first line-craft supervisors. It should be mentioned that large work-planning boards may be substituted to serve in place of the planning sheets.

3. **Preliminary meeting with first-line craft supervisors.**—After the job-planning sheets have been prepared, a meeting is held by the maintenance engineer with first-line craft supervisors who are to have charge of the work at the turnaround. This meeting is held approximately 1 week prior

*Assistant head, maintenance and construction department Baton Rouge refinery, Esso Standard Oil Co.

Drawings being reviewed at headquarters by coordinators with craft supervisors



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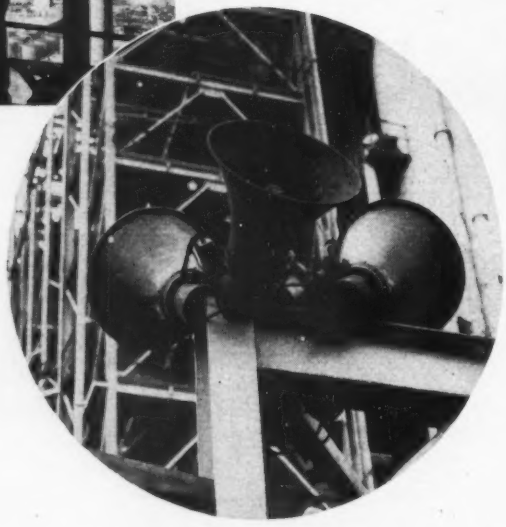
One of the temporary telephones installed in the structure. These phones tie in directly with the general refinery telephone system

A field coordinator checks the progress of a job with one of the craftsmen



One of the clusters of public address speakers required to give complete coverage of the unit

to the turnaround. The various phases of the work are discussed and decisions are reached on problems of preliminary coordination. For special jobs the maintenance engineer also reviews the work at the scene with the craft supervisors involved.

4. **Preliminary work at unit.**—Considerable work is done while the unit is in operation prior to the turnaround. Scaffolds are built, advance shop work is performed, materials are delivered to the site, and other special arrangements are made in advance so as to minimize unit downtime.

5. **Unit shutdown schedule.**—A precise time schedule is developed for shutting down the unit so as to be assured of no delay on the date designated for starting the turnaround.

Coordination and Meetings During Turnaround

6. **Turnaround desk coordinator.**—From two to five extra men are assigned to assist the maintenance engineer during the turnaround period. These men take part in the preliminary arrangements and have special assignments during the turnaround directed towards expediting the work. One man serves as the desk coordinator having a desk in the unit control house or at some other central point in the area which is used as the turnaround headquarters. The job-planning sheets, drawings, and any other such information pertaining to the turnaround are available at these headquarters.

7. **Turnaround field coordinators.**—In addition to the desk coordinator one to four field coordinators are provided to work under the direction of the maintenance engineer, each being assigned a section of the unit in which to expedite the work. The field coordinators report the progress of the work to the desk coordinator where a current record is kept of the turnaround progress. The coordinators are in continual contact with the maintenance engineer and assist the engineer in every way possible in coordinating and expediting duties.

8. **Meeting during turnaround with first-line supervisors.**—Each morning (generally at 10 o'clock) a meeting of all first-line craft supervisors is held at the turnaround headquarters with the maintenance engineer serving as leader of the meeting and with the process operator, process supervisor, and other interested persons in attendance. The progress of the work up to that time, difficulties requiring correction, assignments for the next day, and other pertinent topics are discussed at this meeting.

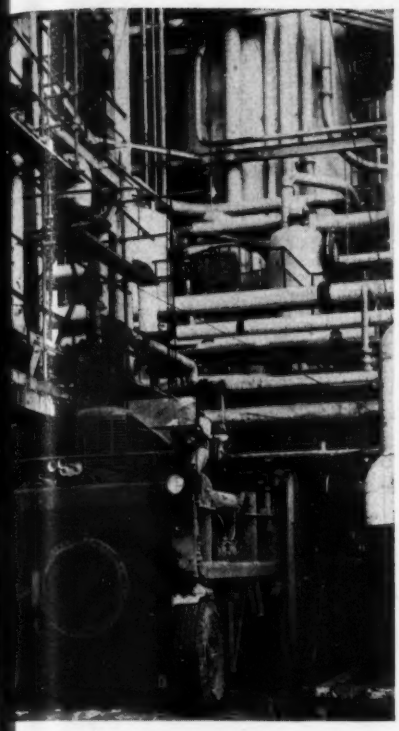
9. **Turnaround records.**—The desk coordinator keeps a record of actual manpower assignments to the turnaround by days, checking these against planning sheets to be sure that no phase of the job is overlooked and that the prearranged schedule is being observed. The coordinator also maintains a log book containing pertinent happenings during the turnaround. Entries include any notes on delays encountered, completion dates of various phases of the job, recommendations for possible improvements in future turnarounds, as well as any other significant information.

Public-Address Systems And Telephones

10. **Public-address system.**—A large public-address system arranged to cover the entire turnaround area is provided, principally for paging and other such uses. As many as twenty 15-watt speakers are used to give adequate coverage to a large unit. The microphone is located on the desk at the turnaround headquarters, and the desk coordinator serves as operator of this system.

11. **Telephone calls.**—Special lines are provided off of the refinery dial system for telephones which are temporarily installed at the unit for use during the turnaround period. At the large units there may be as many as eight temporary telephones of this sort provided.

A special telephone number is assigned to the turnaround site, and all incoming calls are answered by the desk coordinator who through the use of the public-address system is able to contact with the persons wanted. Anybody in the area can use the temporary telephones for making calls to other parts of the refinery and, in certain cases, to other sec-



coordinator gives a progress report over the public-address system to all employes in the area. This report is short, perhaps three or four sentences in length. The public-address system is also used in a similar manner to call attention to housekeeping problems or other such topics. In addition, the system can be used to advantage in the event of any emergency difficulty such as a happening that might require immediate discontinuance of all hot work.

Industrial Equipment and Special Arrangements

14. **Motorized equipment.**—This coordination system lends itself very advantageously to maximizing the use of cranes, trucks, and other motorized equipment during the turnaround. The desk coordinator keeps in contact with the operators of this equipment and dispatches them to the various locations where they are needed.

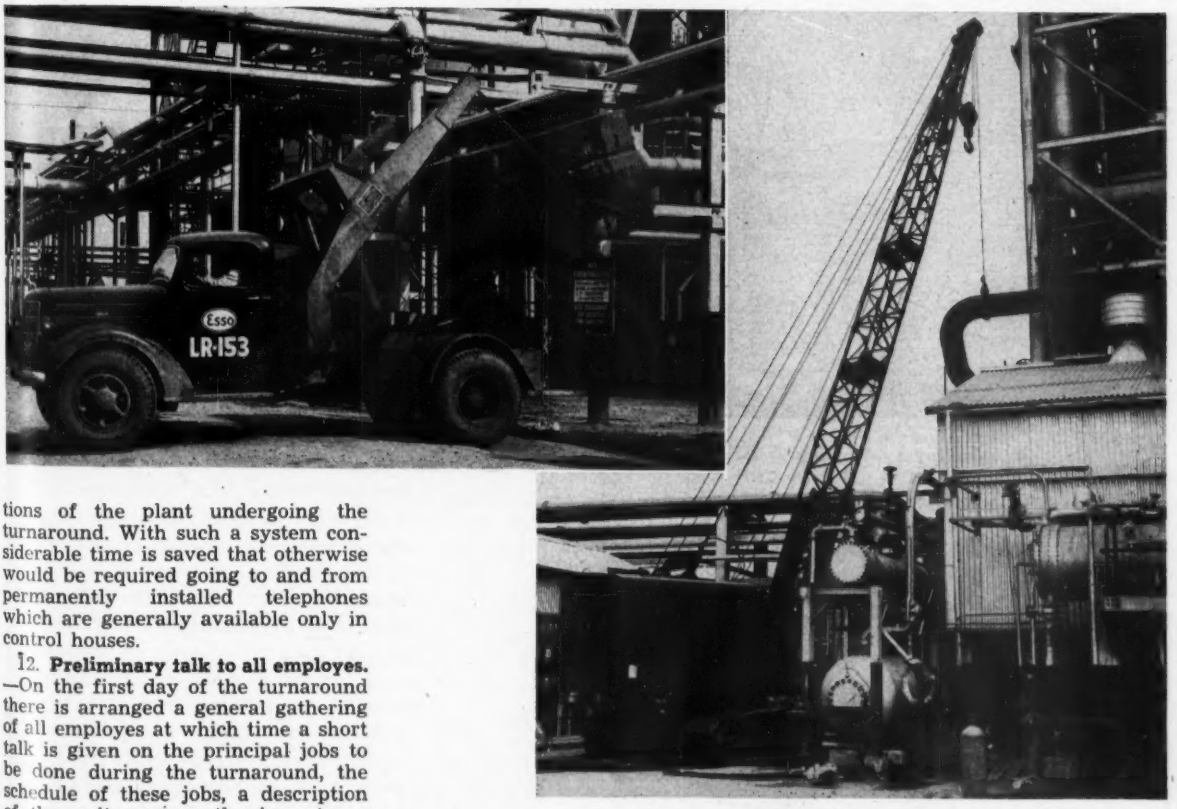
15. **Other aids during turnaround.**—Special drinking fountains are provided in the turnaround area along with extra trash cans. Bicycle racks are also temporarily located in the area for the turnaround period. It is contemplated that trailers will be used in the future for turnaround headquarters as well as for tools and stores supplies.

16. **Closeout meeting.**—At the very end of the turnaround a final meeting is held with the first-line craft supervisors and others who had a part in the turnaround, at which time recommendations are received for improvements that might be made in future turnarounds.

17. **Turnaround report.**—After completion of the turnaround, a report is prepared by the maintenance engineer with the assistance of the coordinators giving pertinent information such as man hours required for the turnaround, significant entries from the log book, and recommendations for improvement in future turnarounds.

System is Successful

This complete system has been used for nearly a year at the Baton Rouge refinery and good results have been obtained. During the time the system has been in operation, many new avenues for further improvement of coordination and planning have become apparent. Many of these possibilities are being developed at the present time, and it is expected that there will be continued progress in the future.



Motorized equipment is used to maximum advantage with typical uses being (top) straddle truck removing a tube bundle; (center) special dump truck handling a container, and (bottom) crane in a close location

tions of the plant undergoing the turnaround. With such a system considerable time is saved that otherwise would be required going to and from permanently installed telephones which are generally available only in control houses.

12. **Preliminary talk to all employes.**—On the first day of the turnaround there is arranged a general gathering of all employes at which time a short talk is given on the principal jobs to be done during the turnaround, the schedule of these jobs, a description of the unit process, the importance of returning the unit to service, and other pertinent information.

13. **Progress report.**—Immediately following the morning meeting at turnaround headquarters, the desk

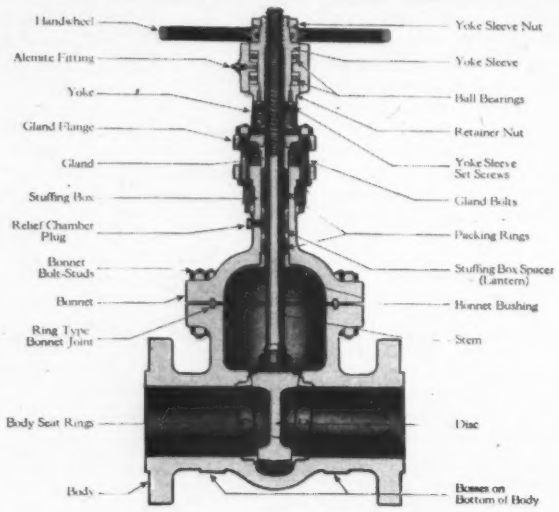


Fig. 1—Cross-section of a typical gate valve. (Courtesy Crane Co.)

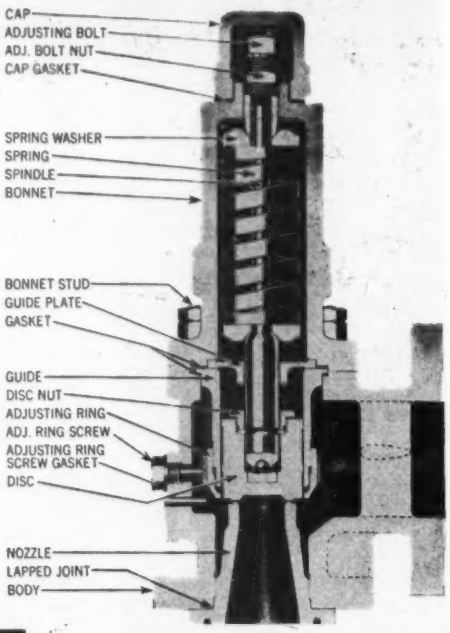


Fig. 2—Cross-section of a typical relief valve. (Courtesy Crosby Steam Gage & Valve Co.)

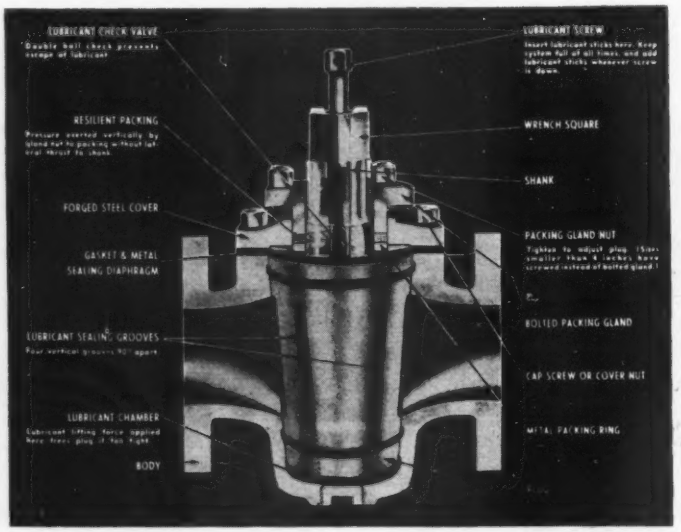


Fig. 3—Cross-section of a typical plug cock. (Courtesy Merco-Nordstrom Valve Co.)

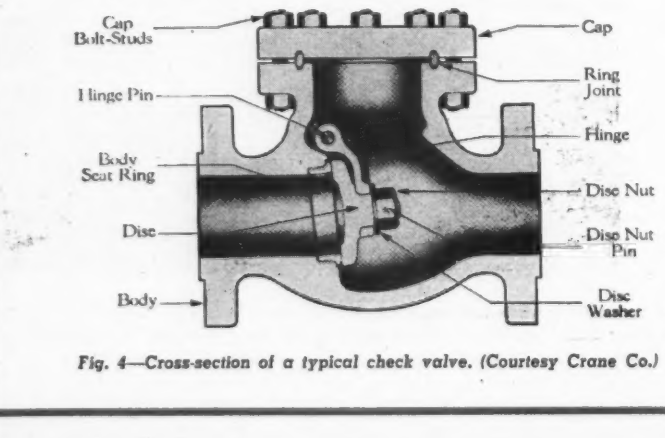


Fig. 4—Cross-section of a typical check valve. (Courtesy Crane Co.)

Symposium on MAINTENANCE

"More—with less"

"The upkeep of property and equipment"

"Maximum efficiency and longest possible life"

"Longest possible service consistent with safety" . . .

These and many other definitions are used for the term "maintenance." However, regardless of terminology, the subject is one of great importance to the refining industry. With this article the Journal introduces a "Symposium on Maintenance." Different authors give their views on maintenance in many of the major subdivisions of the refining field . . . fire-fighting equipment, storage tanks, cooling towers, valves, steam boilers, boiler furnaces, turnaround planning. Additional articles will appear in subsequent issues.

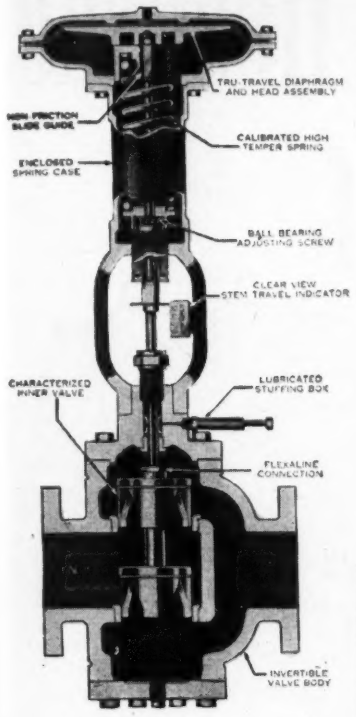


Fig. 5—(Left) Cross-section of a typical control valve. (Courtesy Fisher Governor Co.)

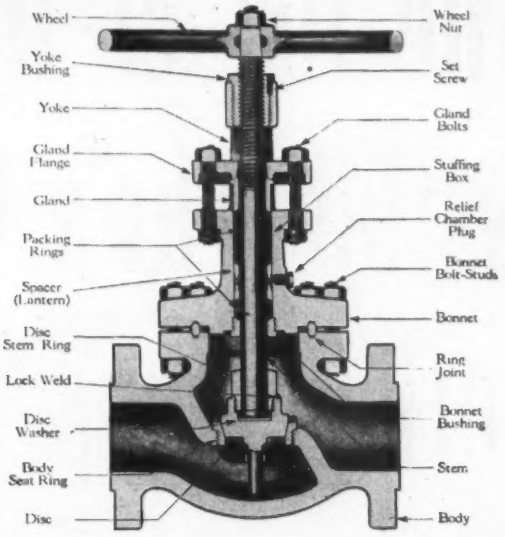


Fig. 6—Cross-section of a typical Globe Valve. (Courtesy Crane Co.)

Principles in Design of a VALVE Repair SHOP

by R. M. Kolb* and D. G. Debo†

FLEXIBILITY should be the main consideration in designing a valve repair shop for an oil refinery. This is apparent when it is considered that thousands of valves of all types and descriptions must be maintained in this shop. Line production methods are practically ruled out, because of the wide differences in the types of valves that must be repaired, and because of the nature of the work itself. Apparently, the best approach to the problem is to have the same workers that start the repair on a valve carry it through to completion. It is a wise move to locate the valve repair shop within or near the machine shop, since the use of machine tools is often required in valve repair.

In general, the numerous valves used in an oil refinery fall into six categories:

1. Gate valves (see Fig. 1).
2. Relief valves (see Fig. 2).
3. Plug cocks (see Fig. 3).
4. Check valves (see Fig. 4).
5. Control valves (see Fig. 5).
6. Globe valves (see Fig. 6).

In each of the above categories there are valves made by different manufacturers of various line sizes and pressure ratings. Even valves made by the same vendor can vary considerably in design and in the material use for constructing the valve, depending on the corrosiveness and temperature of the stock being handled.

Valves are normally sent to the shop only when they give trouble. The most common causes are: (1) Leakage past the sealing surfaces; (2) freezing in the open or closed position; (3) broken or twisted valve stems; (4) leakage past the valve packing. An experience record on important valves should be kept and from this record trouble can be anticipated and the repair made before the difficulty actually materializes. Most of the valves in a large refinery are subject to routine inspection, and when trouble is found these valves are also sent in for repair.

Despite the wide differences in valves handled in a valve repair shop, the procedure for repair is essentially the same. The steps followed are listed below:

1. Measure the wall thickness of the body and bonnet to be sure it is sufficient for the service the valve is in. This is usually done by the engineering inspection department.
2. Completely clean valve inside and out.
3. Dismantle valve far enough to examine critical parts.
4. Determine what repair and part replacement is necessary.
5. Do this repair work.
6. Reassemble valve.
7. Pressure test valve.
8. Return valve to job.

*Associate staff engineer, and †head engineer engineering service department, Standard Oil Co. (Indiana), Whiting refinery.

The list of Houdry licensees is the Who's Who of petroleum progress

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Fig. 7—A gate valve held in vise ready for disassembly

Fig. 8—Body-seat ring in a gate valve being lapped smooth by using a hand lapping block

This repair procedure is described below for each category of valves.

Repair of Gate Valves

The part nomenclature used on Fig. 1, which is a cross-section of a typical gate valve, will be used throughout the discussion on gate valves. Usually the body and bonnet wall thicknesses are measured in the field by the engineering inspection department and if the castings are found too thin, the valve is replaced. When a valve is discarded, the component parts that are in good condition may be kept for spare parts.

When it is known that the body and bonnet are sufficiently thick to permit repair, the next step is to thoroughly clean the valve. Steam cleaning works well on most valves in oil service; however, valves have been cleaned successfully by immersion in solvents; such as kerosine, gas oil, oakite, etc. Coke, which sometimes forms within valves in hot oil service, can best be removed by burning with a welding torch, using a neutral flame, and taking care not to overheat the casting.

Dismantling Valve

To dismantle a valve of this type it should be held firmly while the bonnet studs are removed. Fig. 7 shows the valve held in a large vise. Air-driven impact wrenches are very useful in dismantling some valves, but box wrenches are often used, as it is difficult to get to some of the attaching nuts. Some nuts are difficult to remove when the studs are badly corroded. In this case, it has been found that considerable time can be saved by severing the studs with a cutting torch. After the body and bonnet have been separated, the valve stem is removed and the packing is removed from the stuffing box.

The sealing surfaces are now inspected carefully to see what repair is required. If the disk and seat rings are not too badly worn, they are repaired by lapping. Fig. 8 shows a seat ring being lapped smooth. This is best done by using a lapping compound between the seat and a hand lapping block. The hand lapping block is a disk, usually made of annealed cast iron, and perfectly flat on both sides. The motion used in lapping should be of an oscillating nature, similar to that used in grinding automobile valves. Lapping compounds are classified as: coarse, medium, fine, very fine, and very, very fine. The severity of the wear determines in what order the compounds should be used. If a coarse compound is used first, it should be followed by successive lappings with finer compounds until the desired surface finish is obtained.

The valve disk is also finished by lapping on both sides. Fig. 9 shows a valve disk being lapped on a rotary lapping plate. The same compounds used for lapping the seat rings are

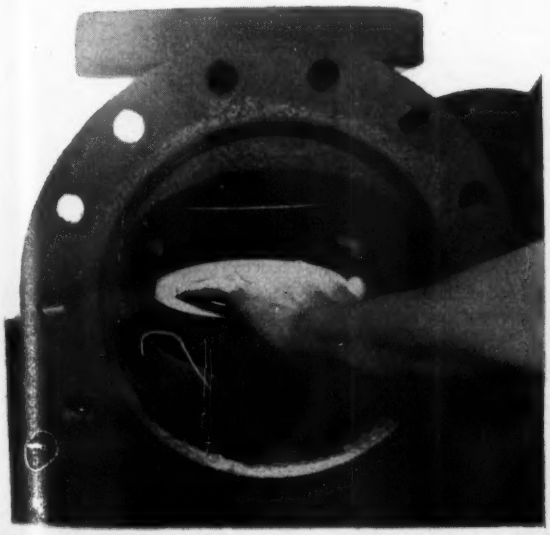
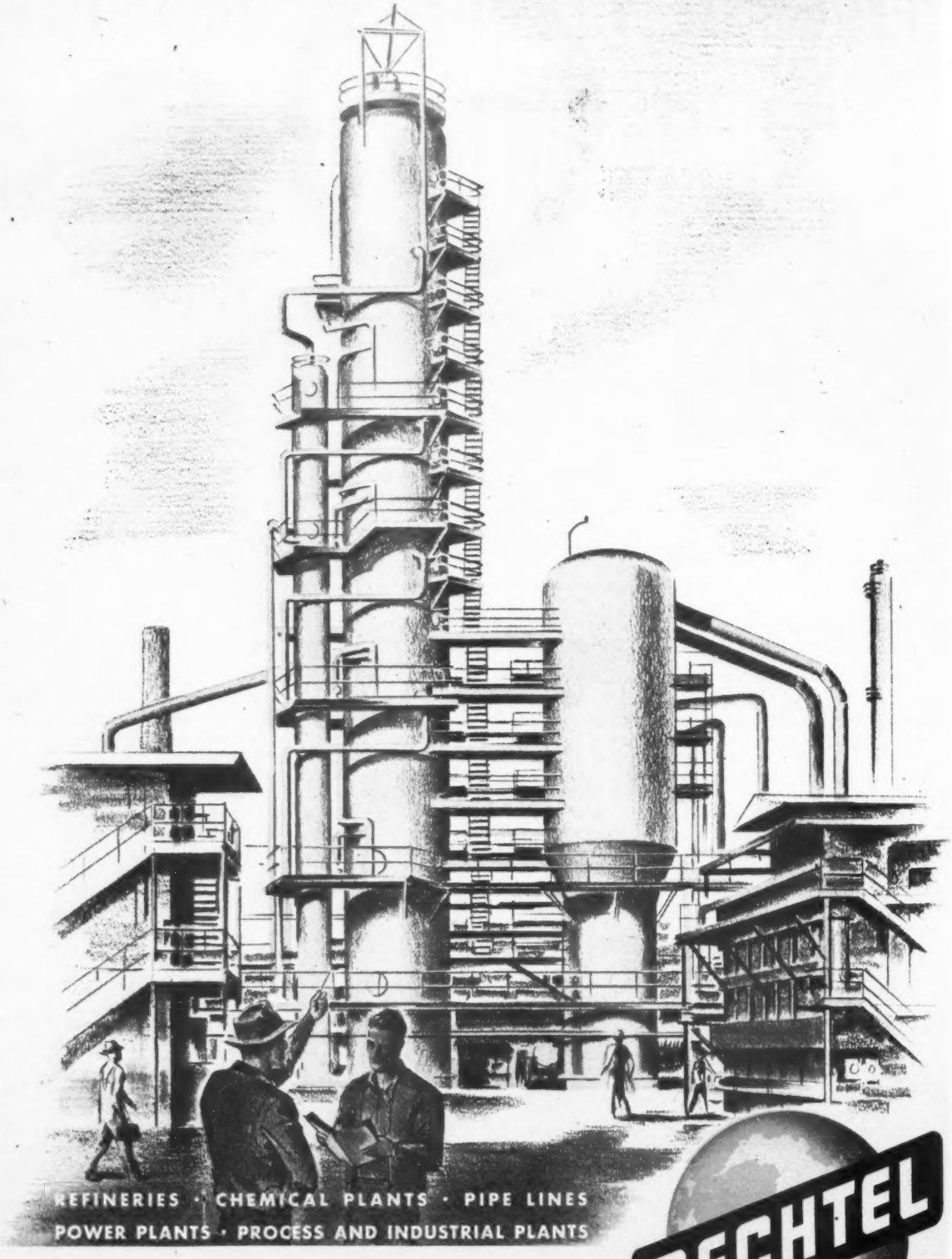


Fig. 9—(Left) A gate-valve disk being lapped on a rotary lapping plate

Fig. 10—(Below) A gate-valve body ring, left, and the tool used for installation and removal, right

BUILDERS FOR INDUSTRY



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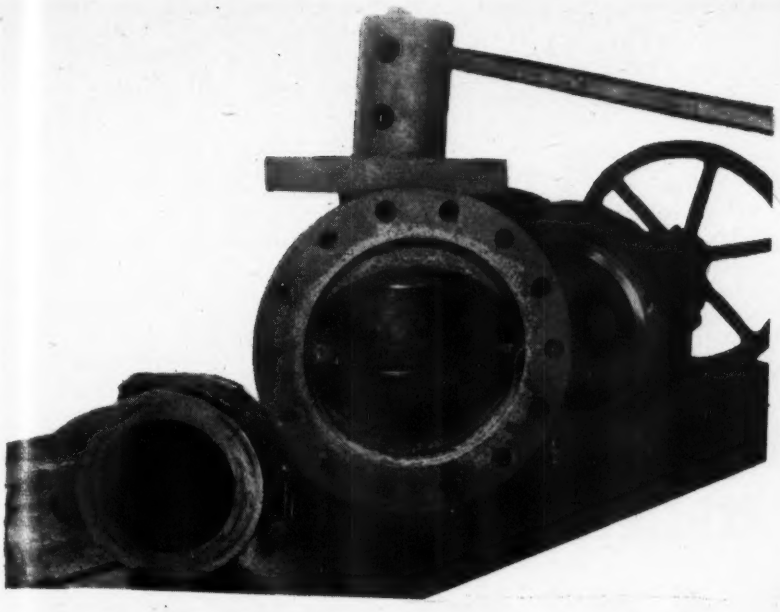


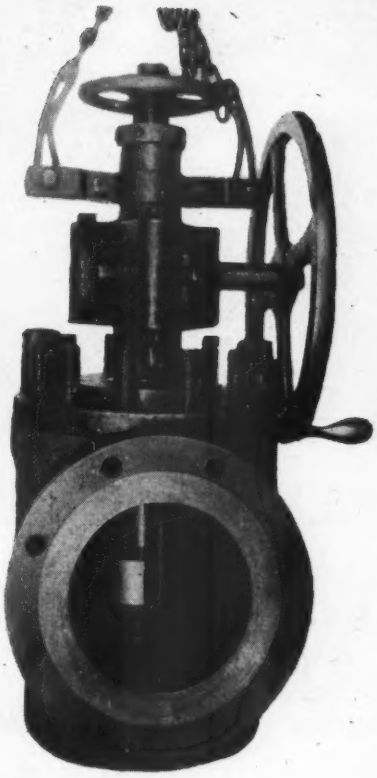


Fig. 11—(Left) The body-seat ring-removal tool ready to take the seat ring out of a gate valve

Fig. 12—(Right) A gate-valve disk being refaced on a surface grinder

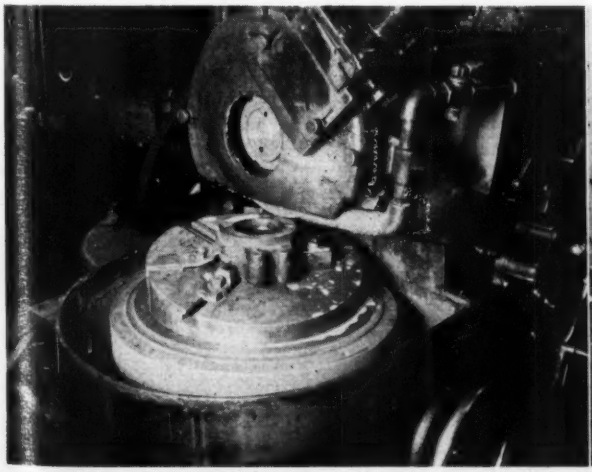
used in lapping the valve disk, and the same sequence of lapping, working from coarse to the very, very fine compound, is used. When the sealing surfaces are properly "lapped in," they are tested by lightly coating the faces of the disk with prussian blue, and dropping the disk into place. If a good continuous seat is obtained, it is almost certain that the valve will be tight.

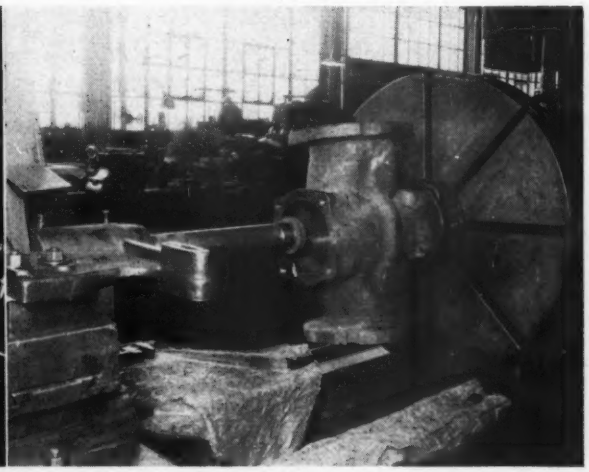
If the disk and body rings are too badly worn to be repaired by lapping, it is necessary to install new parts. Often it is quite difficult to remove the body rings from the valve body. Body rings are usually provided with lugs on the inside diameter so that they may be removed. Fig. 10 shows a valve seat and the tool used for its removal. Fig. 11 the removal tool is shown in place ready to remove the body ring. Torque is applied by pulling on the crow bar. Sometimes the body rings become cemented into place by coke forming behind the screw threads. When this occurs, the valve seat is heated to a cherry red with a welding torch and allowed to cool. This heating and cooling results in cracking the coke and permits easier removal of the body rings. Sometimes the body rings are so badly frozen in the body that they must be cut out in a lathe. After the old rings are removed, the new body rings are installed using the same tool as shown in Fig. 11. It is good practice to coat the threads of the body seat rings with a suitable lubricant so that removal will be easier on the next repair. After the new seat rings are installed, the sealing faces are lapped with very, very fine compound to remove any burrs or distortion resulting from installation.

The new disk is then tried to see if it fits in between the body rings. Often it is necessary to remove a considerable amount of metal from the disks. When this occurs, the disk is mounted in a grinding machine and ground to the proper thickness. This

(Continued on page 252)

Fig. 13—(Left) A relief-valve nozzle-reseating machine mounted on the relief-valve body and ready to operate. Fig. 14—(Right) A plug-cock body mounted in a lathe to be reground with a special grinding attachment





MAINTENANCE AND REPAIR OF VALVES

by R. P. Hendrickson*

REPAIRING WEDGE DISK VALVES

1—Stem removed for placing in good condition via light polishing with fine emery cloth

2—Valve disk held in vise seat, face up. Fine emery cloth rubs entire bearing surface to smooth finish

3—Body seat rings are lapped to give good disk fit

EVERY refinery unit includes quantities of pipe, valves, and fittings, together with considerable other equipment. Where piping is used, the maintenance of valves is indispensable.

The two types of valves most commonly used are gate valves and globe valves. Each have their purpose. Gate valves provide a straight through flow with little, if any, restriction. In a globe valve the direction of flow passing through the body is changed and this results in greater resistance. Each of these designs have certain advantages. A globe valve is used when it is desirable to throttle or pinch the flow. A gate valve, on the other hand, should never be used for throttling, since the velocity of flow against a partly open disk may cause vibration and chattering, resulting in damage to the seating surfaces. Then too, with the disk in a partly open position it is subjected to severe erosion or wire drawing.

To obtain the best service from valves, assuming that the valve selected is the proper valve to use for the service, a regular and frequent inspection should be made. Moving parts such as the stem threads passing through the yoke sleeve or yoke bushing, as well as the yoke sleeve bearings, should be lubricated regularly. In case a valve is found leaking slightly, it would be advisable to remove the valve and grind or lap

*Manager, Oil Sales Section, Crane Co.

MAINTENANCE plays an important part in the operation of all refinery units, large or small. There are two kinds of maintenance—preventive maintenance and plant maintenance. Preventive maintenance applied to valves means the selection of proper valves (design and materials) at the time of original construction, or the replacement of valves not suited for the service with correct valves to minimize shut down periods and costly maintenance.

in the disks and seating surfaces. Such quick repair will lengthen the service of the valve considerably. If a leaky valve is not repaired until such time as the leak becomes serious, it might necessitate replacement of the body seat rings and the disks.

The stuffing boxes and stuffing-box packing are an important part of the valve. The packing is retained in the stuffing box by means of a gland flange or a packing nut, depending on valve design, which bears on a gland in the stuffing box. In case of leakage, the stuffing nut or gland flange should be pulled down until leakage stops. Care should be exercised to tighten the bolts evenly in pulling down the gland flange so the gland will not bind on the stem. In order to stop leakage, it is sometimes necessary to repack the stuffing box. This usually can be done without removing the valve from the line, as all leading makes of valves have a machined collar on the stem and matched seating surface in the bonnet for back seating valve when it is wide open.

Repair Procedure

As mentioned above, leaks at the seat in valves, if permitted to continue, become serious and may damage seating surfaces beyond repair. When it has been definitely determined that the seats leak, repairs should be made as follows:

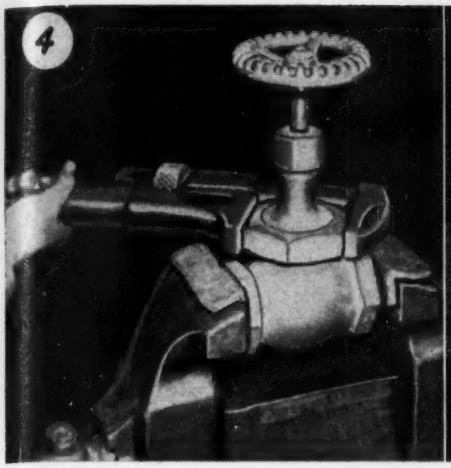
To illustrate the procedure of making repairs, a solid wedge disk valve is used. The same general method, however, applies to other types of gate valves.

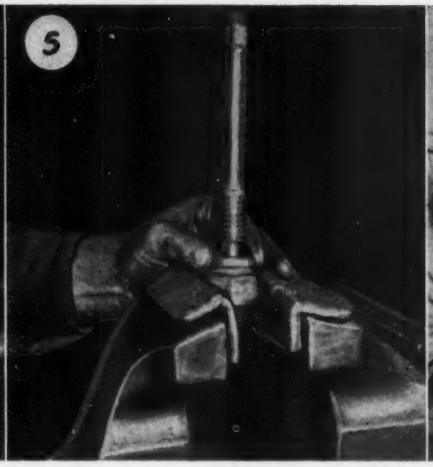
After removing the bonnet, clean and examine the disk and body thoroughly.

Carefully determine the extent of damage to body rings and disk. If corrosion has caused excessive pitting or eating away of metal as in the case of guide ribs in body, it may be impractical to attempt repairs. A complete checkup and servicing of all parts of valve is recommended. Remove the stem from the bonnet and examine it for scoring and pitting where the packing contacts the stem. Light polishing with fine emery cloth is all that may be needed to put the stem in good condition.(Fig. 1.)

Remove all packing and thoroughly clean the stuffing box.

At the same time clean inside of valve bonnet and other parts to remove all dirt, scale, corrosion, etc., so that the interior of valve will be free of all foreign particles. If valve has a flat gasket it should be re-





moved completely and replaced with on of proper material and size.

If ring-type joint is used, the oval or octagonal metal ring can be cleaned, and if not pitted, can be used again. After completing the cleaning and examining of all parts and it is found possible to repair the valve by refinishing disk and body seat rings, or by replacement of body seat rings, proceed as follows:

Place disk in vice with seat face up.

Wrap piece of fine emery cloth around a flat tool and rub or lap the entire bearing surface, (both sides of disk) to a smooth even finish. Remove as little metal as possible. The usual cuts and scratches found on body seat rings can also be repaired by lapping. Use an emery block small enough to permit rubbing of seat ring faces all around (see Fig. 2).

Work carefully and watch closely. Avoid removal of too much metal to prevent disk seating too low. When seating surfaces (disks and body seat rings) seem to be properly lapped, coat face of disk with prussian blue and drop it into the body to check the bearing. When a good continuous contact is obtained between the disk and body seat ring face, the valve will be tight and is now ready for reassembly. When assembling, insert stem in the bonnet. Install new packing. Assemble other parts including gland and gland flange, and then attach the disk to the stem. Replace bonnet gasket, and place the complete assembly in the body. Lift the disk off the body seat ring face so that the bonnet can be properly seated on the body before tightening the bolts. Pull bonnet bolts up evenly in pairs diametrically opposite each other. Good practice suggests testing repaired valve before putting back in service. This assures that repairs have been properly made and stuffing box is tight.

When body seat rings in gate valves must be replaced, they can be removed and replaced best with a power lathe. Chuck the body with rings vertical so that seat faces will be parallel with face plate. Use a steel bar across the body ring lugs to unscrew them. Removal of rings can be accomplished by hand by means of a cold chisel or hack saw to split the ring and then collapse it. Extreme caution should be taken so that the body-ring threads in the body are not damaged. New rings must be pulled up tight against the shoulder on the ring so that leakage will not occur around the body ring. To tighten, place a steel bar across the lugs and pull up with a wrench. Be sure to coat the threads with a good lubricant before inserting the ring into the body. Lap in the same as when repairing a ring ash shown in Fig 3 for perfect fit to the disk.

Repairs on globe and angle valves can frequently be made without removing them from the line. However, it is desirable when any repairs are needed to remove the valve from the line for thorough inspection and cleaning. To illustrate the general procedure for regrinding disks and seats in globe valves, a plug-type disk valve is used. However, the same method applies to other globe and angle valves except those with composition disks. Procedure is as follows:

Hold valve firmly in a vise with stem vertical. (Fig. 4.)

(Continued on page 258)

REPAIRING GLOBE VALVES

4—Grip as shown to dismantle

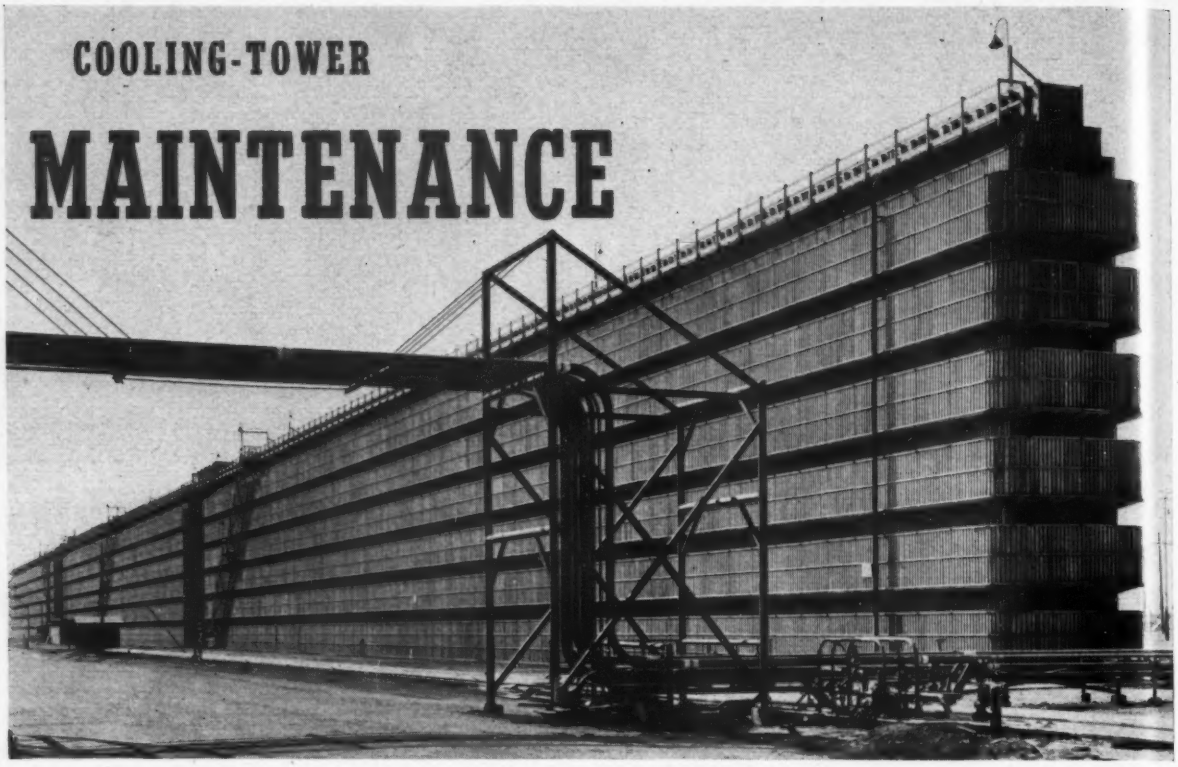
5—Unscrewing disk stem ring

6—Here stem has been lifted out and a spacer or coin is being inserted

7—Applying a light coating of an emery-base grinding compound

8—Valve gets its final assembly and is ready for new service

COOLING-TOWER MAINTENANCE



Whether big installations (like the tremendous multiunit above) or little, periodic tower maintenance pays dividends. On the succeeding page of this article appear maintenance schedules for both atmospheric and mechanical-draft towers

by James G. DeFlon*

COOLING-TOWER maintenance is a subject which, in the past, has not received sufficient attention from plant operators. In most plants there is a program of preventative maintenance for all operating equipment, and such a program should certainly be extended to include cooling towers. There is little doubt the inaccessible location of most towers, either on a roof or on the outskirts of the plant, is responsible for this. However, it should be remembered that an adequate supply of cold water is most essential for satisfactory and efficient plant operation.

The very principles upon which the cooling tower functions also give rise to the problems of its maintenance. For instance, in order to obtain the desired cooling of circulating water, it is necessary that evaporation take place, and this creates a new problem by increasing the salt content of the water.

In order to perform satisfactorily, cooling towers are usually installed in open, unobstructed areas where wind velocities are such as to allow dust, dirt, and debris to be carried along. Since the air passes through the tower over which water is falling, the debris would be washed out of the air and into the basin, and another problem is created.

In order to keep the salt content of the water in the basin to an absolute minimum, and also to remove any collected dirt, dust, and other debris from the basin, it is recommended that a continuous blowdown be made a part of the cooling tower system, and that the tower be scheduled for periodic shut-downs so that the internal filling of the tower and the basin can both be cleaned.

*Chief engineer, Manufacturing Division, The Fluor Corp., Ltd.

Water Treatment

It is well to remember that the maintenance of the tower, exclusive of any mechanical equipment, is closely associated with the quality of the water used. It is therefore almost impossible to discuss cooling-tower maintenance without discussing cooling-water treatment. The problem of water treatment is an entire field in itself. The following is the general opinion of a number of plant operators and is not intended to be a solution to a specific water-treatment problem, but is to be used only as a guide in this matter. For specific problems, it is recommended that any one of a number of companies specializing in water treatment be contacted. Briefly, however, water treatment is done to control algae and scale formation, and to prevent deterioration of the materials used in the construction of the equipment.

Many operators have found chlorine to be one of the most suitable agents for the control of algae. In many plants satisfactory algae control is obtained by injecting 6 to 8 lb. of chlorine per day for each 1,000 g.p.m. circulated. If this amount is consistently added to the water, however, a type of algae immune to chlorine will soon develop. Therefore, every 10 days or so for a short period of time the amount of chlorine supplied to the system should be increased several times, thus preventing this chlorine-immune algae from developing.

Generally speaking, by controlling the pH of the cooling-tower water, it is possible to control the rate of scale deposition in piping and on exchanger tubes. The higher the pH of the water, the greater the tendency for a scale to deposit. When the pH is below seven, little or no scale deposition occurs; rather, the metals in contact with the water slowly begin to dissolve. The latest, most satisfactory practice is to keep the pH of the water between 6.5 and 7, and then to add a corrosion inhibitor to the system. This keeps the piping and exchanger tubes clean, and prevents the metal from corroding. However, the above treatment should be attempted only under the advice of a water-treating specialist.

In certain areas of the western United States, the water tends to be very alkaline due to the presence of sodium, calcium, and magnesium salts occurring in the form of bicar-

bonates. This situation is further aggravated as the cooling tower tends to concentrate the salts in the system. It has been found that when the pH of the water is over 9.0, and when large amounts of bicarbonates are present, the structure of the wood in the cooling tower may be seriously affected. It is particularly noticeable where the wood is alternately wet and dry, a condition which occurs on the sides of an atmospheric tower. At these points the bicarbonates concentrate, and turn into normal carbonates. The carbonates attack and dissolve the lignin in the wood, producing an effect which is termed delignification. This is evidenced by a soft, spongy, stringy wood structure which appears to be decayed. The only way delignification can be absolutely prevented is to remove the bicarbonates from the circulatory system. This is impracticable in many cases. However, plant operators report delignification can be controlled by keeping the pH of the water below 8.5.

Once the importance of the water problem is understood, the operator should next consider the scheduling of a regular inspection and maintenance program for his cooling equipment. This regular inspection program should include the distributing system, filling, outside covering (paneling, louvers or aerators, and drip panels), framework, basin, drift eliminators, coil-shed sections, and mechanical equipment.

Distributing System

The importance of maintaining the distributing system at peak efficiency cannot be overemphasized. The function of the distributing system, as the term indicates, is to distribute the water uniformly over the top of the tower, and to break it up into fine particles in order to expose as much water surface as possible to the air. There are four general types of distributing systems in common use today, namely, the upspray, the downspray, the flume, and the pan-type. However, before discussing the specific types of systems, it is well to point out that, regardless of the type of system employed on new towers, it will be necessary to inspect the nozzles every week or two for the first 3 months of operation. That is, to make sure that any wood splinters, shavings, or other debris normally found in a new tower have not plugged some of the nozzles.

The upspray system consists of a central header with pipe side arms to which, at regular intervals, are attached to the upspray nozzles. This system ordinarily operates at 5 to 6 lb. nozzle pressure, and depends on centrifugal force rather than small orifices for fine breakup of the water. The nozzle orifices are usually about 1 in. in diameter. This large opening, together with the 5 or 6 lb. pressure drop is sufficient to prevent algae, small rocks, and sand from plugging the nozzles. The system is usually located about 6 to 8 ft. below the drift eliminators on mechanical draft towers, and about the same distance from the top of an atmospheric tower. The nozzles spray upwards and completely fill the spray chamber with finely divided water. This type of system will distribute water uniformly under a wide variation of flow. This system requires a minimum of attention, but it should be inspected every 9 to 12 months and any obstructions in the nozzle should be removed. This inspection, of course, is predicated upon the fact that the system is inspected, as mentioned above, during the first 2 or 3 months of operation.

Downspray systems consist of a central header with pipe side arms to which, at regular intervals, are attached downspray nozzles. This system is usually located as close to the top of the tower as possible and operates on about 1½ lb. nozzle pressure. Because of the low pressure, the nozzle must operate on the principle that water impinging on a plate will be distributed uniformly. This system will perhaps not keep itself quite as clean as the upspray system; however, it too will uniformly distribute water with a wide variation of water flow. This system should also be inspected every 3 to 6 months.

The flume-type system is composed of a main flume extending around the outside of the cell with interconnecting side flumes. This flume is usually constructed of wood. In the bottom of the flume, holes are usually bored into which are inserted plastic discharge tubes. Two to three feet directly below each discharge tube is a plastics splash plate upon which the discharge stream from the flume impinges. The effect of the stream of water falling on this plate causes a splashing action which distributes the water. This type of system is not as flexible as the two types previously described. At high water rates the flumes overflow and at reduced water rates the water may not be uniformly distributed. This type of system presents a number of maintenance problems. The flumes tend to open up at the seams, and the splash plates may have to be renewed periodically. The flumes form an ideal place for sludge, algae, and sand to accumulate and therefore they require frequent cleaning. Also, since the algae growth varies with the water temperature the open flumes offer an ideal place for its growth. This type system should be inspected every 30 days and repairs made immediately. If allowed to get into a state of disrepair, the performance of the tower will be seriously affected, and the cost of making the repairs will be increased.

Another type of flume system is the open-pan type, which covers the effective part of the cooling tower. In

(Continued on page 259)

ATMOSPHERIC TOWERS.— Minimum maintenance schedule:

Once Per Week

Inspect suction-pit screens and clean as required.

Once Per Month

Inspect flume-type distributing systems and clean as required.

Once Every 3 Months

Inspect and clean downspray distributing system.

Once Every 6 Months

Inspect and clean upspray distributing system.

Once Per Year

Shut down tower and thoroughly clean, particularly the distributing system, filling and basin. Inspect thoroughly the structure together with the filling, louvers and aerators. Any repairs should follow immediately. Should tower contain a flume-type distributing system, it should be releveled and repaired as required.

MECHANICAL DRAFT TOWERS. — Minimum maintenance schedule:

Once Per Week

Inspect suction-pit screens and clean as required.

Once Per Month

1. Check oil in gear case for level and contamination.

2. Lubricate universal-joint-type couplings.

3. Inspect and clean flume-type distributing systems.

Once Every 3 Months

1. Check downspray distributing system and clean if necessary.

2. Inspect disk-type couplings for fractures in disks.

Once Every 6 Months

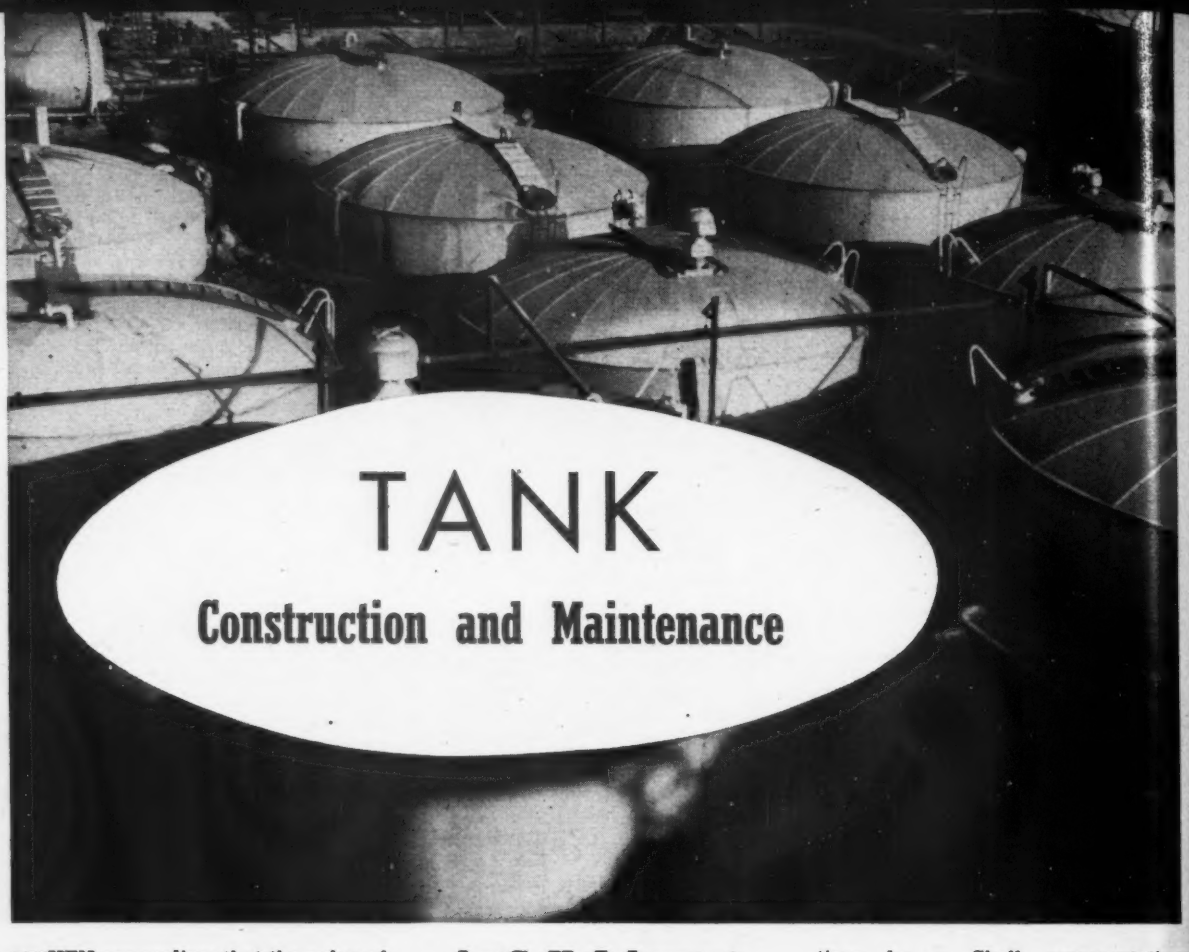
1. Drain and refill gear case with recommended oil.

2. Lubricate motor bearings.

3. Check upspray distributing systems.

Once Per Year

Tower should be shut down and thoroughly cleaned from top to bottom, including basin. Inspect thoroughly the structure. Make necessary repairs and replacements. Should the tower contain a flume-type distributing system, it should be releveled and repaired. Mechanical equipment should be checked for alignment; bolts anchoring this equipment to tower should be tightened. Inspect fans. The gear-type couplings should be serviced and gear-box bearings and seals examined for wear.



TANK

Construction and Maintenance

by C. K. Johnson*

WHEN one realizes that the value of the tanks within an average refinery may represent several million dollars, one can readily understand that the construction and maintenance of all tanks demand the best engineering and craftsmanship. This refers to the atmospheric flat-bottom tanks, of which the types differ in the design of the roofs; namely, umbrella, cone, breathing, floating, and lifting types.

The selection of a type of tank depends upon the intended service. Small rundown tanks are either of the umbrella or cone-roof type, the umbrella type being recommended in sizes up to 24-ft. diameter, and having the advantage over the cone type of being self-supporting. However, this advantage is offset by the fact that repairs or renewals can be made on a cone roof without intricate forming of plates. Also, workmen are not so likely to slip and fall on a cone roof and, if vapor losses are to be considered, there is less vapor space under a cone roof.

Cone roofs on larger tanks are selected for storage of oils having high flash points and where vapor losses are not considered too great a factor. Volatile liquids require roof designs for conservation of vapors and fire prevention. Lifter-type roofs may be used for conservation of vapors from an associated group of rundown tanks. Floating or breather-type roofs are used when economical in consideration of vapor losses from large tanks.

*Chief engineering inspector, Wood River Refinery, Shell Oil Co., Inc.

All new tanks at the Wood River refinery of Shell Oil Co., Inc., are designed and constructed in accordance with the A.P.I. Standard 12-C for all-welded storage tanks, which recommends sizes for economical use of steel plate as it is rolled and cut at the mills. Also, the code is designed to provide for construction details and weldings which will permit economical construction and require a minimum maintenance in normal noncorrosive service.

Drawings and Specifications

All tank purchase orders are supplemented by orientation drawings and specifications covering the requirements for each tank. The orientation drawings show the locations and sizes of nozzles, manways, and all appurtenances. Drawings covering standard details such as water-draw-off connections, sumps, suction wells, swing-line pontoons, and foam chambers are also forwarded with the order. Besides stating code requirements, specifications cover unloading of construction equipment and steel, hauling distance to the job site, and utilities available for construction and testing. They also list special requirements covering the inspections by a Shell representative.

Construction is not started until all drawings are approved. The drawings are furnished by the manufacturer sufficiently in advance of construction to make any changes which may be necessary. Complete sets of final approved drawings are furnished for our files for future references during maintenance periods

Shell does not attempt to establish construction procedures as most tank manufacturers have their own methods which have served them best for economical and practical construction. However, the company does have an inspector witness the testing of all welders and follow the work to verify that all is as specified.

Tanks are constructed on bases designed for proper drainage and support for which certain local standards have been adopted. In order to provide proper drainage and to avoid excessive soil corrosion of tank bottoms, sand beds are prepared approximately 4 in. deep and slightly larger in diameter than the tanks. The beds are smoothed and sloped 1 in. per 10 ft. upward toward the middle to slope the bottom toward the outer circumference where the water-drawoff sump is located. The support of the tank or bearing load on the soil is particularly critical at the circumference under the shell. Experience has led to providing suitable concrete foundation rings under tanks of more than 35-ft. height or when the ratio

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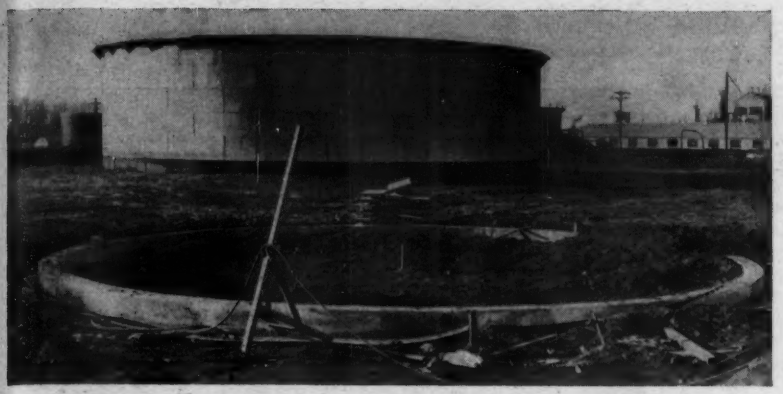


Concrete foundation rings are desirable under tanks of more than 35-ft. height or when ratio of height to diameter exceeds 2½ to 1

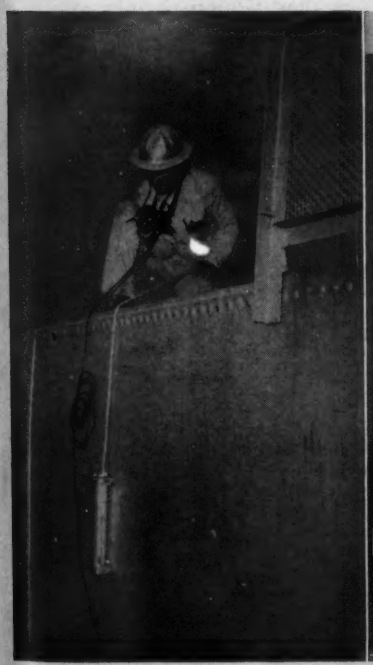
of the height to the diameter exceeds 2½ to 1.

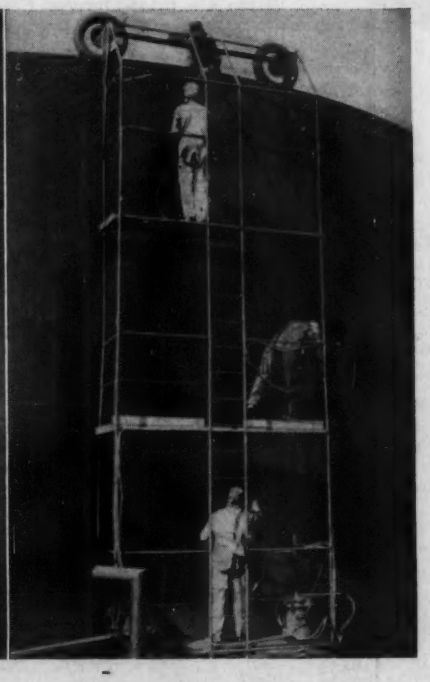
As the bottom plates are laid, the inspector observes whether or not the sand base is unnecessarily disturbed to the extent that the desired slope may not be maintained. The bottom-plate seams are generally single welded lap joints and before they are tacked in place, the inspector sees that all dirt and sand are removed from between the lapped plate edges. If sand or dirt particles are allowed to remain, blow holes in the welds will generally occur when the welding arc hits them. Ordinarily, an experienced construction crew has an adopted procedure for welding the bottoms in order that buckling of the plates will be at a minimum. This is important to reduce working the joints when subjected to a liquid load. Also, a straight bottom is much easier to clean during maintenance periods.

The job of setting the first ring of the shell is followed closely by the inspector to make certain that no nozzle or manway intersects a vertical seam. As additional rings are added, the alignment of the plates and diameters are checked. When ring plates are tacked in place and welding begins for completing the seam welds, trepan core samples are cut out to show cross sections of the welds. All samples are selected and examined by the inspector to make sure that code requirements are met. As stated before, the code allows for economy in construction and this is particularly true in the welding of the shell seams. The tolerances allowed in the undercutting and percentage of weld penetration of the circumferential seams permit rapid

Right: Vacuum box, brush, soap suds, and container are the items needed for testing bottom and roof seams

Below: Two other tank operations: Checking areas for thickness changes, and thorough painting via special revolving scaffolding

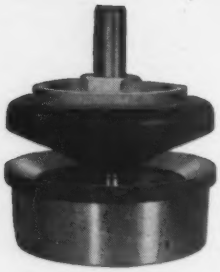




welding. Usually the welders are paid on the basis of lineal feet of weld and some are prone to take advantage of all tolerances. This necessitates the closest inspection. The adopted procedure of welding the shell seams is important in order to eliminate excessive distortion of the plate edges inward or outward, commonly called peaking. Peaking of the vertical seams naturally results in greater stresses when subjected to liquid pressure and may result in failures. In case of floating-roof tanks, peaked seams cause excessive wear on the roof shoes.

Welding of the roof plates usually presents no particular problem, consequently it is not followed so closely by the inspector. The installation of floating-roof seals and shoes is important for maximum service life and is closely checked along with locations of all openings and connections.

Testing a tank consists of testing the bottom and roof seam welds with soap suds and a vacuum box. A section of a seam is coated with soap suds before placing the box over that section. Drawing a vacuum on the



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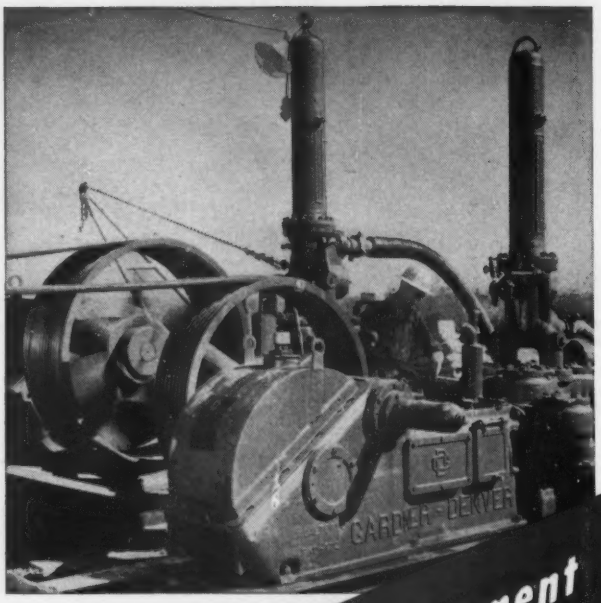

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box after placing it over the soaped weld will produce bubbling of the soap suds where there is a leak in the weld. Roof seams are also tested by applying internal air pressure of 1.5 times the vent-valve setting or a maximum of 3 in. of water, then soaping the welds. The tank is filled with water for testing the welding of the shell. All welds are closely checked and where leaks are found, repairs are made by chipping out and rewelding as required by the code.

The service of a tank within an oil refinery is such that the commodities stored may change or cleaning may be necessary several times before any maintenance repairs are required. Therefore, a tank is seldom removed from service for only inspection purposes. Each time a tank is opened and cleaned for operating purposes an inspection is made to determine necessary repairs and to establish the anticipated service life. Complete records are maintained for each tank. The records consist of fabrication drawings, erection data, age, inspection data, service of the tank at the time of inspection, and necessary maintenance.

Pitting and Corrosion

The inspection of tank bottoms often reveals internal pitting and general corrosion. Pits exceeding 50 per cent of the bottom-plate thickness are repaired by filling with weld metal. Severely corroded areas are generally patched by welding plates over the areas. Where the bases for the older tanks were not prepared for proper drainage, soil corrosion is often encountered. To determine the extent of this, coupons are cut out and examined. The holes left by these coupons are patched and, if there is any question about whether there are any undetected holes, the tank is floated in water and examined for leaks. Often it becomes necessary to install a new false bottom to eliminate the maintenance of the original bottom. This is done by laying a 3 or 4-in. sand bed over the old bottom, laying a new bottom on the sand, and welding it to the side plates.

Measurements of the side-wall thicknesses are obtained each time a tank is inspected unless no appreciable corrosion is experienced after long periods of service. Formerly, the measurements were obtained by drilling test holes, tapping, and plugging them. Now, measurements are obtained by the use of nondestructive instruments.

Although tanks have been built all welded during recent years, we have many old tanks of riveted construction. The riveted seams of these old tanks are found to be weakened with only one or two sixty-fourths of an inch loss in plate thickness as determined by calculation and this is evident by the number of leaky seams which cannot be made tight by repeated efforts to caulk them. Under these conditions the liquid level in the tank is limited as long as it remains in service.

Internal corrosion sometimes requires filling of pits with weld or patching an area of concentrated pits in the lower ring of the shell plates; however, the most severe corrosion usually occurs at the top ring. When the thickness of the top ring is reduced to an arbitrary minimum allowable thickness of 6/64 in., the liquid level is lowered to the ring below. This is considered only a temporary measure and may increase the corrosion rate since the plate will be exposed to vapors 100 per cent of the time.

Corrosion of roof plates and support structure is more severe than either the side or bottom plates. Thicknesses are obtained each time the tank is inspected, and corrosion rates are established. Minor leaks usually occur when the general thickness becomes about 1/16 in. Such leaks can be repaired by welding a patch plate. When these conditions exist and the tank remains in service, a good walkway is provided from the stairway landing to the roof appurtenances which may require maintenance. The walkway reduces the load concentration. The roof structure usually lasts somewhat longer than the plates. A record of its condition is kept and if thicknesses are desired several areas of the roof plates are cut out to expose the structural members at representative locations. Thicknesses can be obtained readily and general conditions observed.

All nozzles and appurtenances are inspected for required maintenance. The old water-drawoff connections under the bottom have required frequent renewals; consequently, these are being replaced by a side-wall connection extended inside and downward into a sump. Conservation vent valves and flame arrestors are inspected at regular intervals of 2 weeks and in some cases more often particularly during freezing weather. Foam chambers and lead diaphragms are inspected each time a tank is opened.

The foregoing was in reference to oil-storage tanks. Chemical-storage tanks in general are maintained somewhat in the same manner, except corrosion is usually more concentrated and severe when it occurs. Concentrated sulfuric acid tanks are affected by internal corrosion most severely on the side walls and at the outer circumference of the bottom plates. Weak-acid tanks are generally lined with lead which requires frequent repairs. Caustic-soda tanks maintained at temperature above 180° F. have been affected by caustic attack. Stressed areas such as welded or riveted seams become brittle and crack. Attempts to repair these by welding usually result in additional cracking. Temporary repairs have been effected by welding 10-in. strap plates over the seams. All plates are sand blasted before welding.

Other than lead lining for weak-acid service, little has been done for the protection of tanks against internal corrosion. Various types of vinyl plastic coatings have been tested for protection against H_2S vapors, sulfuric acid, and caustic-soda attack. While some of these appear to be satisfactory, particularly in the case of caustic-soda service, the economy of the full-scale applications has not been established. Nevertheless, recent experience demands that some protection be provided and some of the new tanks which will be in sour-crude and rundown-distillate service are being protected.

Color standards are established for painting exteriors of tanks. Small tankage of all kinds in capacities less than 1,000 bbl. is painted all aluminum. Distillate and heavy-oil storage tanks between 1,000 and 5,000-bbl. capacity are painted all black; and crude, distillate, and heavy-oil storage about 5,000-bbl. capacity are painted with aluminum top and top ring with the rest of the tank black. Gasoline storage tanks were painted aluminum.

Maintaining paint protection on tanks is a difficult problem. New tanks are sand blasted prior to the application of a prime coat. The condition of the paint is noted at regular intervals or during each general inspection period. It is important to repaint before the prime coat has deteriorated and the metal becomes oxidized. When this occurs, sand blasting is again necessary in preparation for a new prime coat. Wire brushing oxidized areas has been tried as a substitute for sand blasting, but has not always been successful. Records of dates and kinds of paint used are kept for comparing service lives to determine the most economical application and paints used. A special painting scaffold is illustrated in an accompanying illustration.

Standards are established for fire protection of tanks storing oils with flash point below 200° F. These standards cover the minimum distance between tanks as governed by local or state laws, the National Fire Protection Association, the National Board of Fire Underwriters, and the A.P.I. manual on fire protection in refineries. Provisions for adequate fire-wall capacities in relation to the tank sizes are specified. The fire walls may be made of earth, masonry, or reinforced concrete.

Flame arrestors are generally specified for tanks handling products having a flash point below 120° F. Foam chambers are designed for attachment to the top ring of a tank without disturbing the top angle. Chambers designed to direct the foam against the inside of the tank shell are used on tanks up to 65-ft. diameter. Chambers of the Moeller-tube type are used for larger tanks.

Maintenance and Repair of Steam Boilers and Boiler Furnaces

by J. F. Shanley and G. R. Hull†*

BECAUSE of increasing demands for petroleum products, most refineries are processing more and more oil. As a result of this increase in production more attention is being focused on steam-generating capacities in the refineries. One factor in assuring maximum steam-generating capacities is the matter of maintenance and repair of boilers and boiler furnaces. A few difficulties along this line, together with the steps taken for correction, are discussed here. These data pertain to the steam-generating plants at the refinery of the Standard Oil Co. (Ind.) in Whiting, Ind.

At one station in the refinery there are five boilers of 200,000-lb.-per-hour capacity, operating at 400 psig. and a total steam temperature of 650° F. Each boiler has four burners in a wind box, each burner being composed of a conventional oil burner and a ring-type gas burner. On all of these boilers a condition in which metal around the burners burned to such an extent that boilers had to be taken off the line frequently for extensive repair and parts replacement.

In the original design of the connection between the gas ring and the windbox casing, there was a cast-iron ring around the gas burner as shown in the dotted circle in Fig. 1 labeled "original design." As well as holding the ring in place, this cast-iron ring sealed the interior of the wind box from the brickwork throat. In all cases of burning out, this cast-iron ring burned through at its junction with the brick work. Because of a positive pressure in this area, actual combustion was forced through the breaks in the cast iron up along the outside of the wind box casing, going so far as to burn I-beams above the burners.

*Superintendent and †general foreman, utilities and conservation division, Standard Oil Co. (Ind.) refinery, Whiting, Ind.

New Construction Details

To correct the condition, changes were made as shown in the dotted circle in Fig. 1 labeled "new design." The new construction leaves an opening around the gas ring between the ring and the casing and brick work. This is a circular opening entirely around the burner except for the six clips which hold the gas ring in place.

The annular opening is obtained by spacers inserted at each clip fastening as shown in detail A in Fig. 1. Since there is a positive pressure in the wind box a flow of air sweeps any close-in combustion into the furnace,

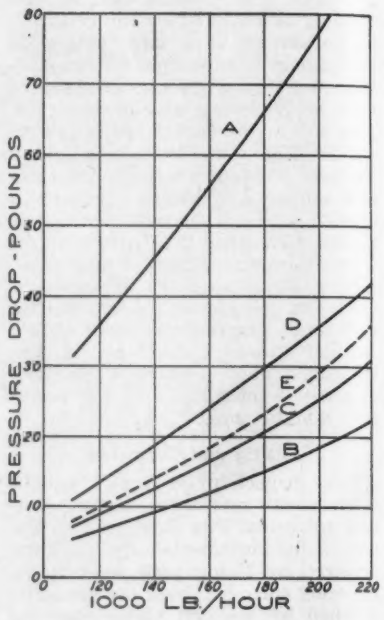


Fig. 2—Curves showing typical pressure drops across economizers at a Whiting refinery power station. "A"—Pressure drop before acid cleaning. "B"—Pressure drop after acid cleaning. "C"—Pressure drop after 1 week's operation. "D"—Pressure drop after 9 weeks' operation. "E"—Pressure drop after water flushing at the end of a 3½-month run

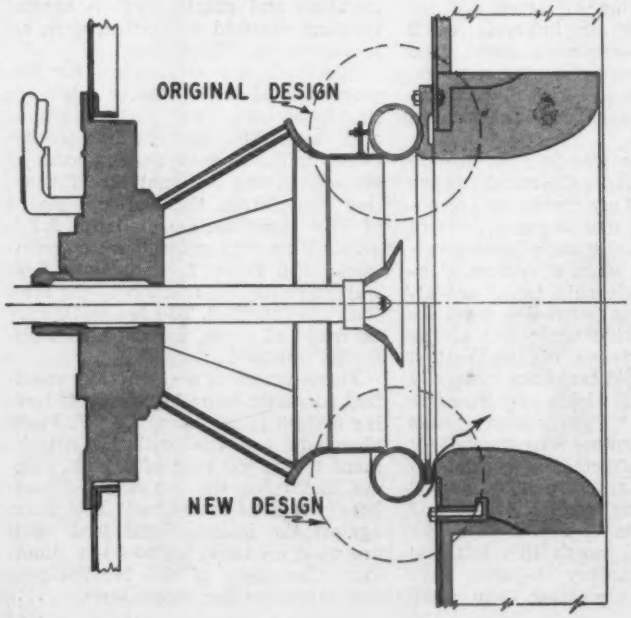
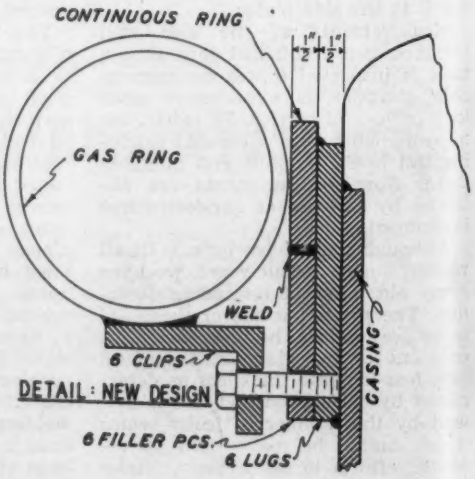


Fig. 1—(Left) Changes in burner construction to eliminate localized destructive combustion. Detail A from Fig. 1—(Below) Six lugs are spaced to conform with clips on gas ring. Lugs welded to ring and casing, and filler pieces welded to lugs and ring



thus eliminating the damaging effect described above. Since this corrective construction was installed, no burning in these areas has been experienced and the down time of the boilers has been materially lessened.

The boilers described are equipped with pendant-type nondrainable superheaters. An excessive number of boiler shutdowns were caused by failures of these superheater tubes. The main cause of these ruptures was overheating due to deposits of solids from boiler water carried over in the steam from the boilers. It is not uncommon for high steaming rates to result in excessive carry over in the steam.

Since the boilers in question receive feed water treated by a hot lime-soda external phosphate treatment all of the solids are water soluble. Hence a schedule was started whereby all of these superheater tubes were washed with water at each boiler shutdown In another station in the refinery, it has been found that even with internal phosphate treatment, where some of the solids are not water soluble, water washing flushes out the insoluble matter along with the soluble solids.

Tubes Individually Washed

Each tube is washed individually to assure complete cleaning. Warm steam condensate is preferred for wash water but boiler feed water in this case was found to be satisfactory. A time schedule for tube washing was established by analyzing the effluent from the wash and stopping the wash when the analysis of the effluent was the same as that of the inlet water. Since the superheaters have been washed at each boiler shutdown, there has been a very marked reduction in the number of tube failures. It is felt that damage done prior to the application of the washes might account for the subsequent failures.

One power station at the refinery has eight boilers which normally deliver a maximum of 160,000 to 170,000 lb. of steam per hour. They operate at 400 psig. and 650° F., total temperature. These boilers have economizers. The boiler feed water, 100 per cent makeup, is treated by the hot lime-soda method. Phosphate is fed internally. An organic treatment is applied upstream of the economizers, but, in spite of this, excessive pressure drops across the economizers were experienced. A lowering of *(Continued on page 264)*

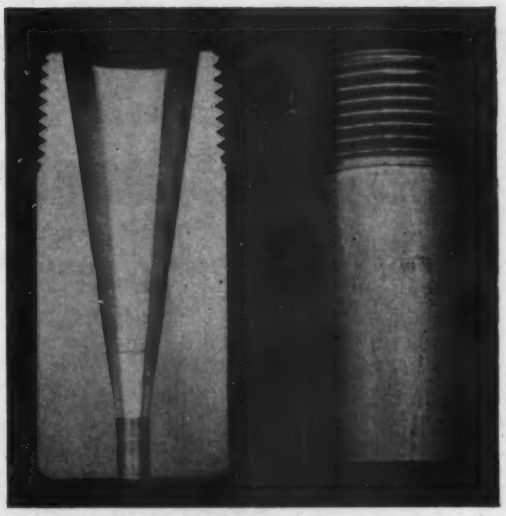


Fig. 3—Jet for use on water lance. Pipe size is ¾ in., throat size ⅛ in.

Fig. 5—Illustration of external corrosion on economizer tubes

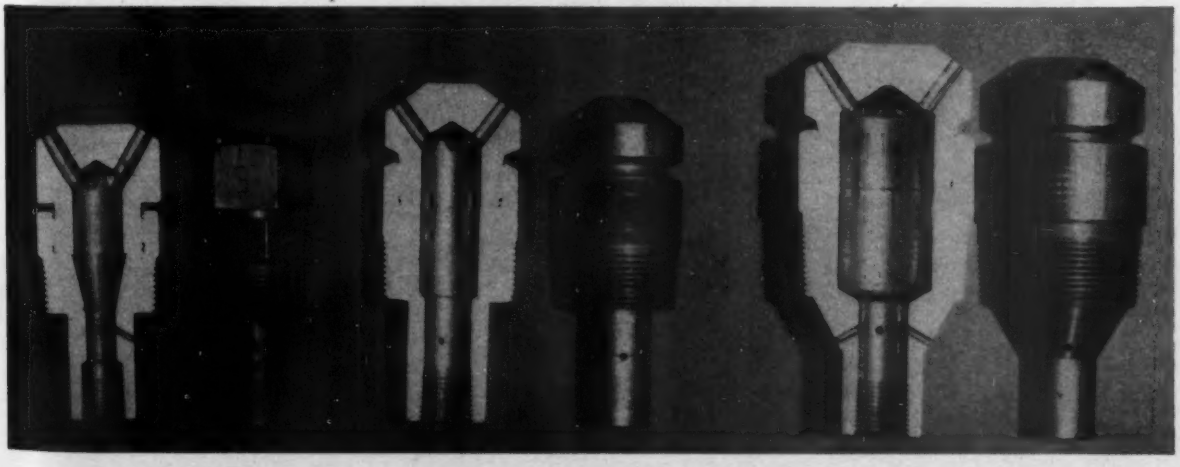


Fig 4—Liquid fuel burners. Left and center burners show steps in development. Burner on right is latest development

Removal of "Bottleneck" Increases Refinery Output

by J. J. Coates*

THE unprecedented demand for petroleum products coupled with a continuation of shortages in construction and processing materials has led refineries to review carefully their operations. Studies were made to determine where increases in throughput and production might be achieved in a short time without the need for major equipment additions. Such a review has been made at the Baton Rouge refinery of Esso Standard Oil Co. and a program of "bottleneck" removals is now under way. By close cooperation among all groups in the refinery excellent results have been achieved and the way is clear for further substantial improvements in the near future.

The normal activities of the chemical division of the refinery include a review of processing operations and the development of engineering projects for equipment additions or modifications to remove bottlenecks in operating units. However, the demand for petroleum products having become so acute, the president of the company requested, in June 1947, that an intensified and formalized program of bottleneck removals be instituted. Immediately following this a review was made of the projects currently being studied by the technical division and certain of them were selected for particular emphasis. At the same time, processing operations were again critically reviewed by the technical and operating divisions and the need for additional projects was determined.

From the original review and from subsequent reviews made during the progress of the program, 111 projects were selected for intensified development directed towards early completion. Of these, 19 had been completed by February 1, 1948. Sixteen of the projects were discontinued after further critical review, and 14 are either in the final stages of construction or await a processing unit turnaround for completion. The remaining 62 projects are in various stages of development.

*Chemical engineer, Petroleum Technical Service, Baton Rouge refinery, Esso Standard Oil Co.

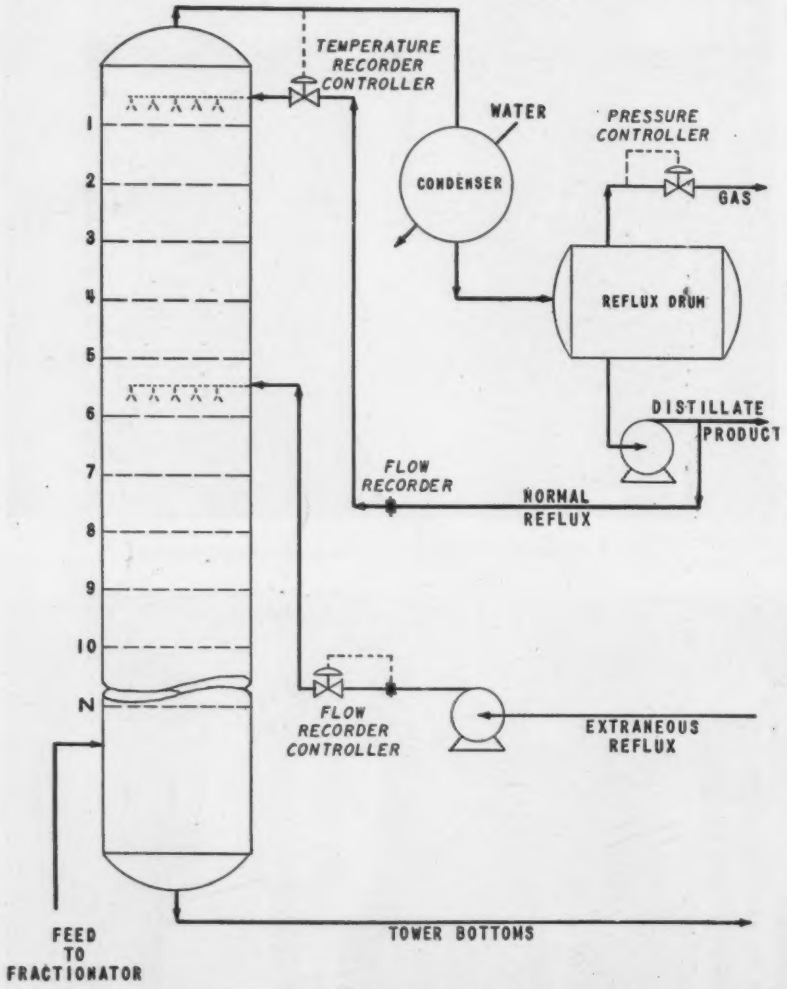


Fig. 1—Practical example of processing "revision" to step up output. Besides the normal bubble-tower reflux, a stock which required rerunning was introduced as extraneous reflux at another point in the tower. Thus that stock could be rerun (4,000 bbl. per day) with little expense and no new equipment to meet the specifications needed.

Advantages of Program

The advantages to be derived from such a program are many. Although much of the activity represents refinery routine, the program serves to consolidate and expedite such activity even though there may be no novelty in the projects. Since an essential part of such a program is a review of operations by a group having an objective viewpoint, new and novel suggestions are certain to be made. With the definite goal such a program emphasizes comes a competitive spirit among the personnel. From this spirit of competition stem new ideas as to how a routine assignment can be better performed. Added to these advantages will be a renewed cooperation among the various groups in the refinery which, of necessity, results in improvements.

The program of "bottleneck" removal set up at Baton Rouge was organized along definite lines. Concurrent with the development of the program has been a renewal of interest in the preparation and review of operating standards. As a part of the program, committees have been formed to review certain refinery operations such as light ends, cracking, and acid handling. A review of conformity of plant operations to standards has become a function of these committees.

Increasing realization values for refinery products have made worth while a study of liquid and gaseous-fuel composition and have permitted investments in equipment to recover fuel components for other uses. A growing demand for liquefied petroleum gas led to a project to recover propane from a fairly concentrated stream previously used as fuel. A

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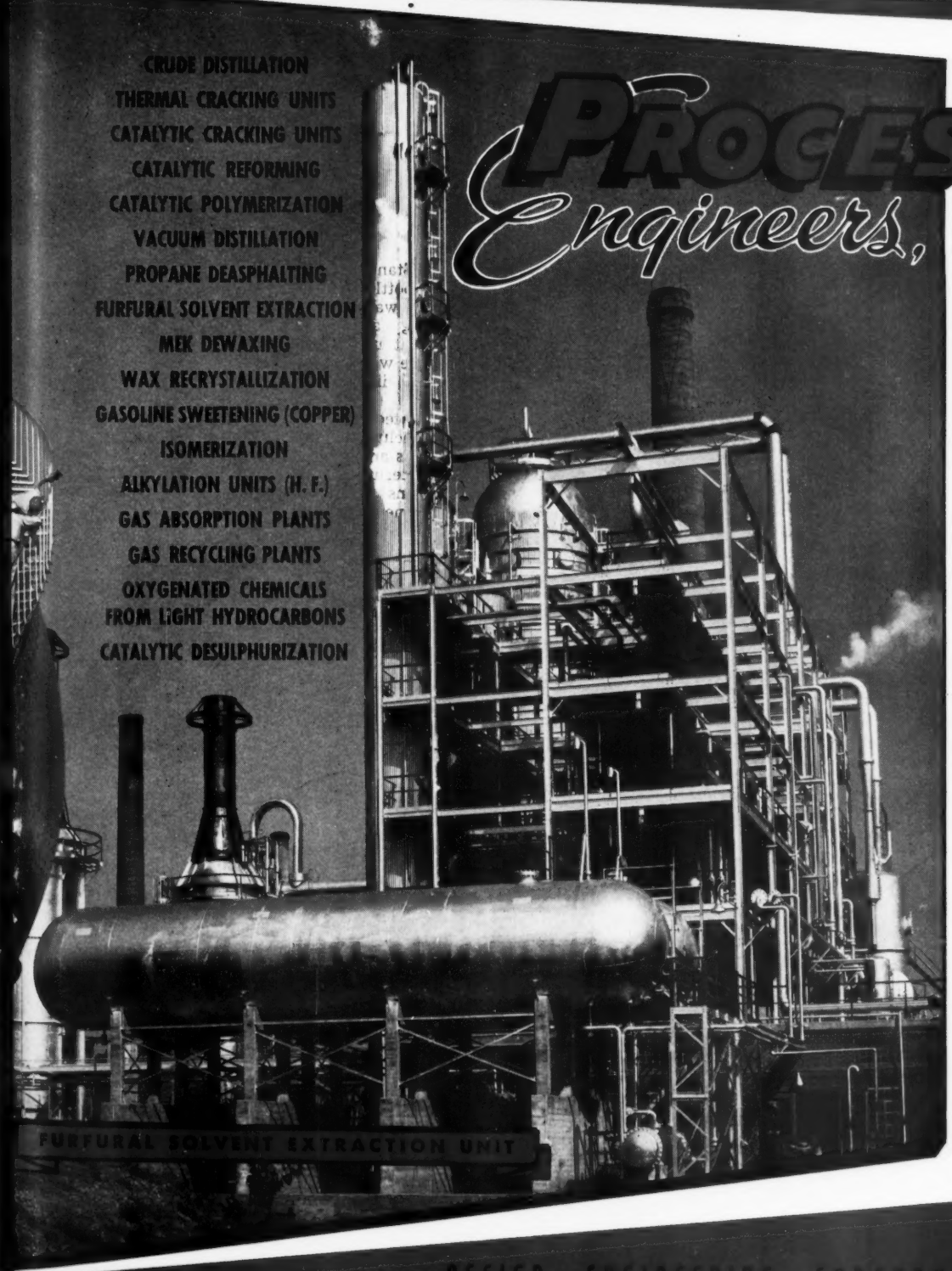

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Clad steel plates make possible the economical construction of large or heavy processing, storing and transporting equipment that will operate satisfactorily even under pressure, vacuum, heat or cold.

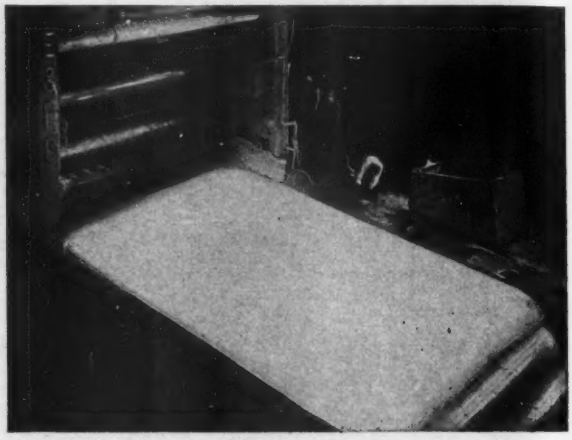
Lukens Clad Steels are normally furnished with the clad thickness equal to 10% of the total plate thickness. However, the clad thickness may be varied to suit operating or fabricating conditions—from 5% to 50%—to provide the same protection as nickel, stainless, Inconel and Monel at a substantial reduction from the cost of solid corrosion-resistant metal.

Lukens Clad Steels are produced by hot rolling. The precision method of assembly and the heavy, uniform pressure employed to bond and reduce the components insure uniform cladding thickness in the finished clad plate.

The backing plate may be any carbon or low alloy steel of standard plate specification. High strength or other properties required in the backing may be obtained from special low alloy steels.

The bond or adhesion strength of Lukens Clad Steels is formed by pressure welding at high temperature on one of Lukens rolling mills. The use of nickel plating on all cladding materials containing chromium assures a permanent bond.

The quenching in water of Stainless-Clad Steel plates with high coefficients of linear expansion from a temperature of 1800° F. revealed no evidence of bond failure after 20 cycles of heating and quenching. To approximate conditions encountered in fractionating towers, samples of 20% Types 347 and 410 clad, ½" thick, were heated to 1000° F., and water quenched to room temperature. This cycle was repeated 350 times with standard ASME shear tests made at intermediate points. The results indicate that the shear strength is not affected and is at least double that of the 20,000 psi. minimum requirement of the ASME the Boiler Code.



Rolling a wide plate on Lukens 206" Mill—world's largest plate mill—for a prominent petroleum refinery.

Lukens Nickel-Clad Steel is used by the petroleum industry for pressure vessels, tube sheets, tanks and other equipment.

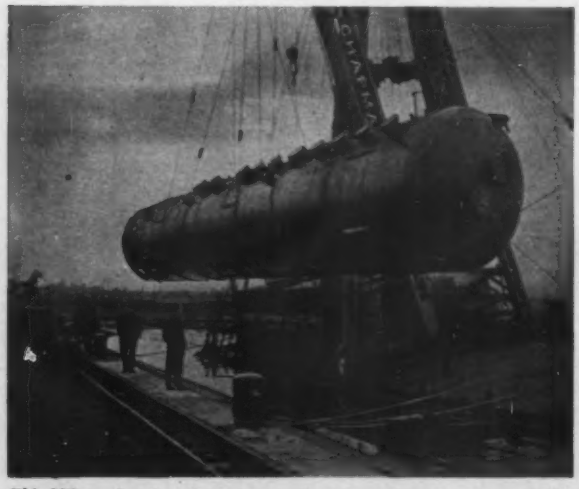
Lukens Stainless-Clad Steels are used for a wide variety of petroleum equipment in applications where stainless is particularly resistant to corrosive attack.

Lukens Inconel-Clad Steel has been used in the petroleum industry in condensers, heat exchangers and other elevated-temperature equipment handling hydrochloric acid.

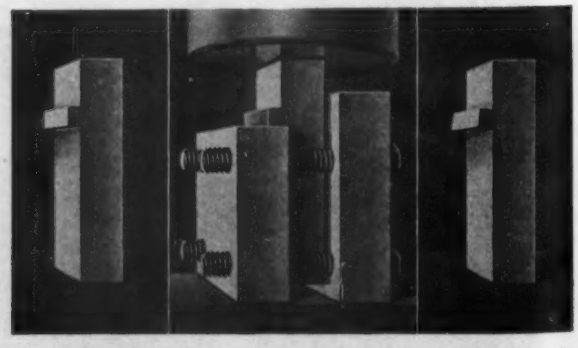
Lukens Monel-Clad Steel is used to withstand acids and caustics in cracking and fractionating towers, hydrofluoric alkylation reboilers and columns, tanks, and other equipment.

Mechanical properties of Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad Steels, as determined by tensile tests, are equal to or better than the strength of the steel usually used for backing, such as A-285 Grade C.

Lukens Clad Steels are high in heat conductivity; Stainless-Clad plates have higher thermal conductivity than solid stainless of the same thickness.



This 155-ton fractionating tower required approximately 27 tons of 15% and 20% Lukens Monel-Clad Steel plates and a 20% Lukens Monel-Clad Steel Elliptical Dished Head, in its upper section. The head was the largest ever spun of Monel-Clad Steel. The tower was fabricated by The M. W. Kellogg Company, Jersey City, N. J., for Standard Oil Company of Indiana.



Stainless-Clad Steel plate specimens, such as shown at left, when subjected to shear strength test (center), sustained pressures of over 48,000 psi, average, showing the high strength of the bond. The specimen, shown at the right after test, failed at 48,600 psi.

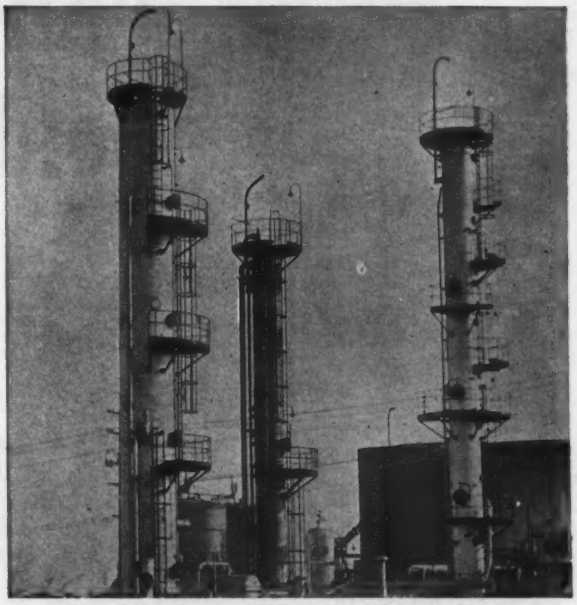
The design of clad steel equipment follows closely general practice for design of similar steel structures.

The economic design of equipment is aided by the availability of large plates and heads which may be obtained in Lukens Clad Steels. See size tables below.

In all applications involving clad steel plates, the widest plate available can always be employed with resulting saving in fabrication costs.

SODIUM HYDRIDE DESCALING

Clad steel plates are descaled at Lukens Steel Company by the sodium hydride method, which assures a smooth, scale-free surface. This modern method removes all the scale without loss of metal, by reducing the scale to metal or lower metal oxides and produces uniform descaling of all surfaces. The treatment removes only the scale, does not attack backing metal. Pickling losses are avoided. Plates retain original dimensional accuracy. The surface of clad steel plates, descaled by the sodium hydride method, is smooth and regular, free from scale. Elimination of scale inclusions in a clad plate prevents electrolytic pitting if the clad surface is brought in contact with chemicals after fabrication.



Nickel-Clad Steel pressure vessel (at left in photograph) for the production of high octane gasoline, fabricated of plates and heads of 15% and 20% Lukens Nickel-Clad Steel.

BULLETINS

"Lukens Nickel-, Inconel-, Monel-Clad Steels," Bulletin 255.
"Lukens Stainless-Clad Steels," Bulletin 338.
"Fabrication of Lukens Clad Steels," Bulletin 399.
"Economic Design, Modern Pressure Vessels," Bulletin 269.
"Uses of Clad Steel to Combat Corrosion," Bulletin 247.
"Fabrication Costs of Boilers, Tanks and Pressure Vessels as Affected by Plate Widths," Bulletin 239.
"Lukens Flanging and Pressing," Catalog 1.
"Lukens Heat Treatment Service," Bulletin 281.
"Heavy Pressing," Bulletin 271.
"By-Products Steel Plate Shapes," Bulletin 270.
"Weldments Designed and Fabricated by Lukenweld," Bulletin 438.

LUKENS STEEL PLATE WEIGHT AND SIZE CALCULATOR will also be sent free on request.

PLATE SIZES* — LUKENS NICKEL-CLAD AND STAINLESS-CLAD STEELS

Gage, In.	LENGTHS, INCHES	WIDTHS, INCHES																					Diam. of Circle
		48	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144	150	156	162	168	174	178	
3/16		480	480	480	480	480	480	440	410	385	365	345	330	315	300				For Sizes Beyond these Limits refer to Lukens					132
1/4		480	480	480	480	480	480	440	410	385	365	345	330	315	300	260	220	180						150
5/16		480	480	480	480	480	480	480	480	480	480	470	450	430	410	390	370	360						150
3/8		480	480	480	480	480	480	480	480	480	480	470	460	440	420	400	380	370	325	310				162
7/16		480	480	480	480	480	480	480	480	480	480	480	480	460	430	410	390	370	325	310				162
1/2		480	480	480	480	480	480	480	480	480	480	480	480	460	440	430	410	370	325	310	195			168
9/16		480	480	480	480	480	480	480	480	480	480	480	480	480	460	450	430	380	325	310	195			168
5/8		480	480	480	480	480	480	480	480	480	480	480	480	480	470	460	440	390	340	310	195	180		174
11/16		480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	460	400	350	310	195	180	178	178
3/4		480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	460	410	360	310	195	180	178	178
7/8		480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	460	420	370	310	195	180	178	178
1		480	480	480	480	480	480	480	480	480	480	480	480	480	480	480	460	430	380	310	195	180	178	178
1 1/8		480	480	480	480	480	480	480	480	480	480	480	480	460	435	420	400	385	370	310	195	180	178	178
1 1/4		480	480	480	480	480	480	480	480	480	450	425	405	385	365	350	335	320	310	300	195	180	178	178
1 3/4		480	480	480	480	480	480	465	435	410	385	365	345	330	315	300	285	275	265	255	195	180	178	178
2		480	480	480	480	470	435	405	380	360	340	320	305	290	275	265	255	240	235	225	195	180		174

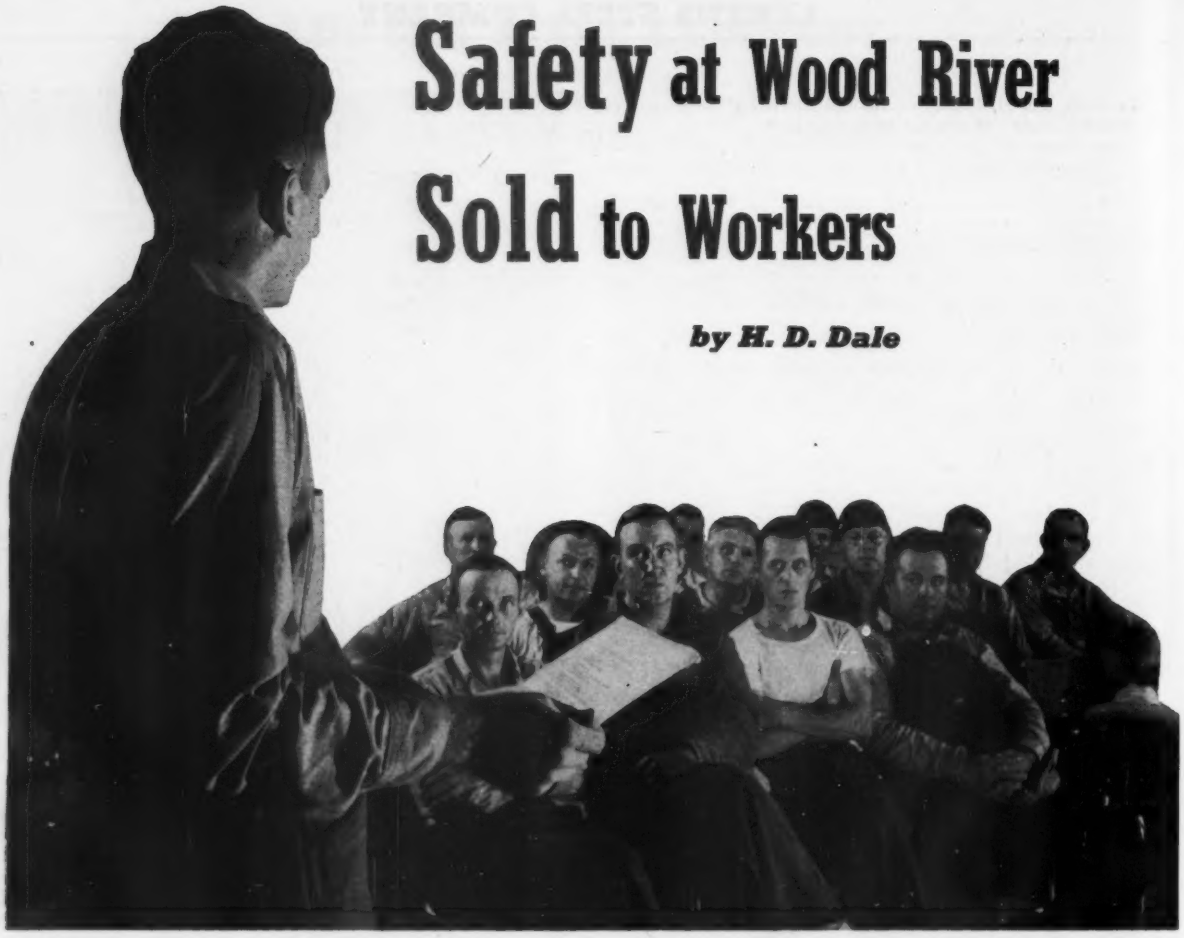
PLATE SIZES* — LUKENS INCONEL-CLAD AND MONEL-CLAD STEELS

Gage, In.	LENGTHS, INCHES	WIDTHS, INCHES																		Diam. of Circle
		48	60	66	72	78	84	90	96	102	108	114	120	126	132	138	144	150	156	162	
3/16		480	480	480	480	480	480	440	410	385	365	345	330	315	300		For Sizes Beyond these Limits refer to Lukens				132
1/4		480	480	480	480	480	480	440	410	385	365	345	330	315	300						132
5/16		480	480	480	480	480	480	480	480	430	410	390	375	355	340						132
3/8		480	480	480	480	480	480	480	480	480	480	460	435	415	395	375	360	345	330	315	300	162
7/16		480	480	480	480	480	480	480	480	480	480	405	380	360	345	330	315	305	290	280	265	162
1/2		480	480	480	480	480	480	480	480	480	480	345	325	310	295	280	270	260	250	240	230	162
9/16		480	480	480	480	480	480	480	480	480	480	315	300	285	270	255	245	235	225	220	210	162
5/8		480	480	480	480	480	480	480	480	480	480	300	275	260	240	230	220	210	200	195	190	162
11/16		480	480	480	480	480	480	480	480	470	310	290	255	210	195	185	175	165				150
3/4		480	480	480	480	480	480	480	460	430	300	275	260	210	195	185	175	165				150
7/8		480	480	480	480	480	450	420	390	370	300	275	260	210	195	185	175	165				150
1		480	480	480	460	425	390	370	340	320	300	275	260	210	195	185	175	165				150
1 1/4		480	440	400	370	340	315	290	275	260	250	230	220	210	195	185	175	165				150
1 1/2		425	370	335	300	280	260	245	230	215	200	185	175	170	160	155	150					144
1 3/4		365	315	285	265	240	225	210	200	185	170	160	150	140	135							132
2		310	270	250	225	210	190	180	175	160	150	140	125									120

* Plates over 456" in Length must be blast cleaned instead of sodium hydride descaled.

Safety at Wood River Sold to Workers

by H. D. Dale



While the Shell Oil Co., Inc.'s, Wood River, Ill., refinery was processing more than 16,000,000 bbl. of oil in a recent 164-day period, for the greatest production in its history, the plant's 3,800 employes established a record of 3,476,721 man-hours worked without a single disabling injury. Safety meetings, held daily so that each employe can attend at least once a month, sparked the drive which resulted in this safety achievement

IN the firm belief that safety is a province of all levels of supervision and manpower, safety thinking begins at the top management levels and carries down through every employe at Shell's Wood River refinery.

At the top policy level is the superintendent-administrative who formulates the general policies and makes the major decisions. Reporting directly to him is the manager of the fire and safety department who is the direct operating head. He carries out policies, coordinates the work of the safety department with the operating departments, makes procedural decisions, and supervises the safety education program.

Assisting the department manager are eight fire and safety inspectors. Carefully selected and trained, these are the men who "sell safety" to the workers. Able to deal with individuals or groups thoroughly familiar with the work of the various crafts and operations, they can instruct in safe work approaches and have the men remember it. They are kept currently informed on fire and safety matters by staff discussion, subscriptions to all of the better safety publications, exchange information, and so forth.

H. D. Dale has been associated with Shell continuously since 1924. He started his first job as tank gager upon graduation from University of Pittsburgh. During his first 8 years he progressed through various positions to head stillman, and in 1933 was named special technologist at the refinery. In 1941 he was made superintendent. He was transferred to New York in 1944 as manager of the operations department and advanced to assistant to the vice president of manufacturing. In 1946, Dale was made manager of Shell's Wood River refinery.

The eight men mentioned previously constitute the actual fire and safety department, but assisting them in every possible way are all supervisors throughout the refinery. Each supervisor attends a safety meeting each month which is conducted by the department manager. In these meetings they are informed of any changes or new practices in safety procedure and discuss unsafe practices. They are encouraged to and do discuss and recommend changes which will be of advantage either in their own departments or crafts or in the refinery generally.

In addition to the supervisory force, practically every individual worker attends a safety meeting at least once a month. These meetings are conducted either by a safety inspector or by a foreman, who has received special instruction from the safety department prior to the meeting. These meetings include discussions of safe practices, new procedures and policies and, again, as in

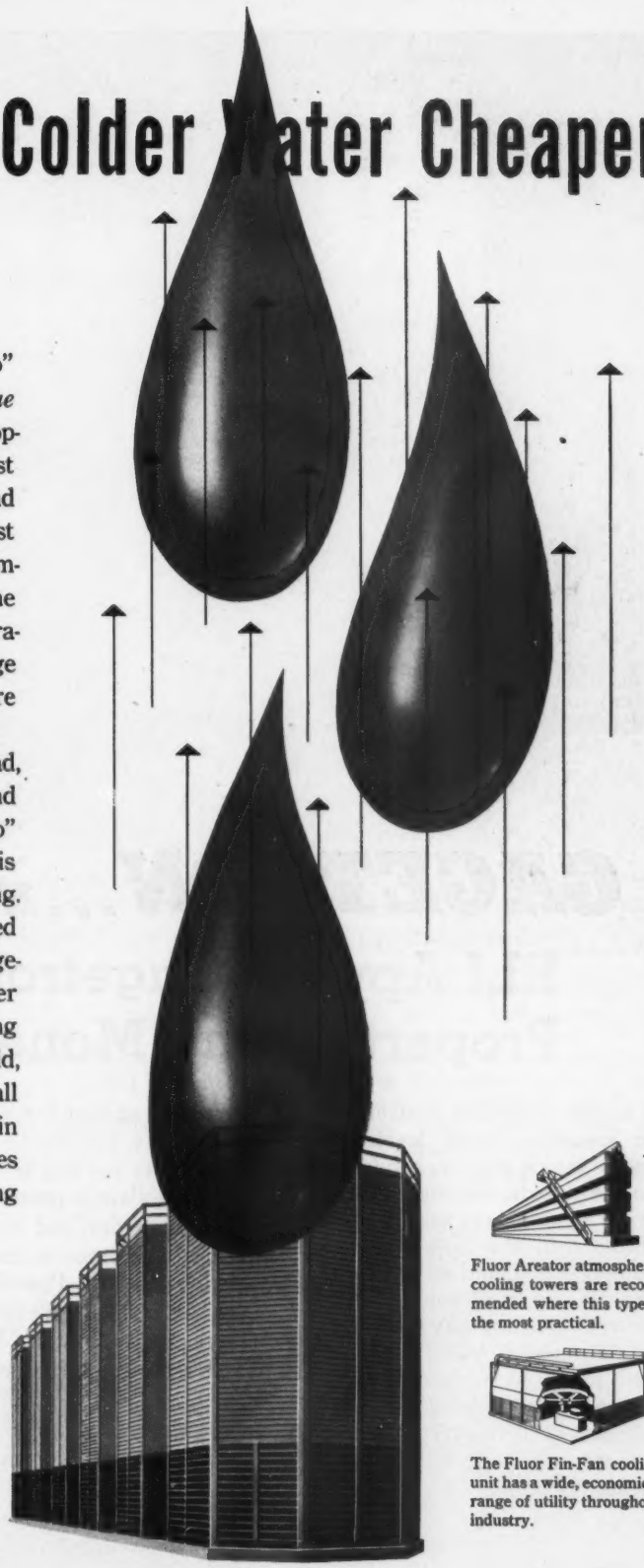
(Continued on page 271)

TRUE COUNTERFLOW = Colder Water Cheaper

Cheaper? Yes, and here's why: Fluor "Counterflo" Cooling Towers incorporate the principle of *true* counterflow: the air current travels directly opposite to the water current. Result? The coldest air contacts the coldest water; the hottest and most humid air (exhaust) contacts the hottest water. All the exhaust air approaches the temperature of the incoming hot water while all the cooling water approaches the wet bulb temperature of the entering air...thus taking advantage of the greatest possible terminal temperature differential so vital to efficient heat transfer.

Assuming tower size, tower height, heat load, water circulation, wet bulb temperature and air quantity are equal, the Fluor "Counterflo" Cooling Tower will deliver colder water than is possible with either parallel or crossflow cooling.

The Fluor octagonal tower design; patented up-spray distribution nozzles; proper arrangement of grid decking to assure longer air-water contact; fan and gearing developed to give long service life and eliminate recirculation; rigid, time-resistant construction throughout... all add up to one net result: less operational cost in the long run. Yes, fifty years' experience proves that... year in and year out... Fluor Cooling Towers deliver colder water cheaper!



6 Cell "Counterflo" Cooling Tower

Fluor "Counterflo" induced draft cooling towers, prefabricated in mass production, are available in multiple or single units in any required size or height.

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The Fluor Fin-Fan cooling unit has a wide, economical range of utility throughout industry.

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The new Gagetron controls and/or measures liquid levels from inside tanks, with no connections to the outside, electrical or otherwise. A gamma ray source is introduced into the tank before the tank is sealed, and all controls are outside the tank, completely unconnected in any way to the inside of the vessel. GAGETRON accurately measures fluid levels, or controls these levels efficiently and safely. The GAGETRON has proved especially helpful where unstable liquids are used, as a prevention against fire, explosion, poisonous fumes and other hazards. Its use has saved thousands of dollars in possible loss by explosion or fire, and has greatly lessened the danger to crews while gauging liquids. Possibilities of the GAGETRON application are practically unlimited. Engineering Laboratories, Inc. welcomes any liquid level problems you might have, and will be glad to furnish detailed information regarding the GAGETRON.

A GAGETRON AT WORK

Gagetron can distinguish between fluids. Thus, in Crude Settlers in one refinery where salt water is settled out of crude to the bottom of the vessels, a control of the level of settled out salt water may be maintained below the danger level by use of the GAGETRON. The GAGETRON radium source was placed well below the level where water would pass over to the furnace, and the detector outside the tank at the same level. When water replaces crude at this level, GAGETRON causes an alarm horn to sound, and lights to flash on in the instrument house. When the operator draws the water level down, the instrument returns all signals to normal. GAGETRON STEPS UP EFFICIENCY, REDUCES SHUT-DOWN TIME.

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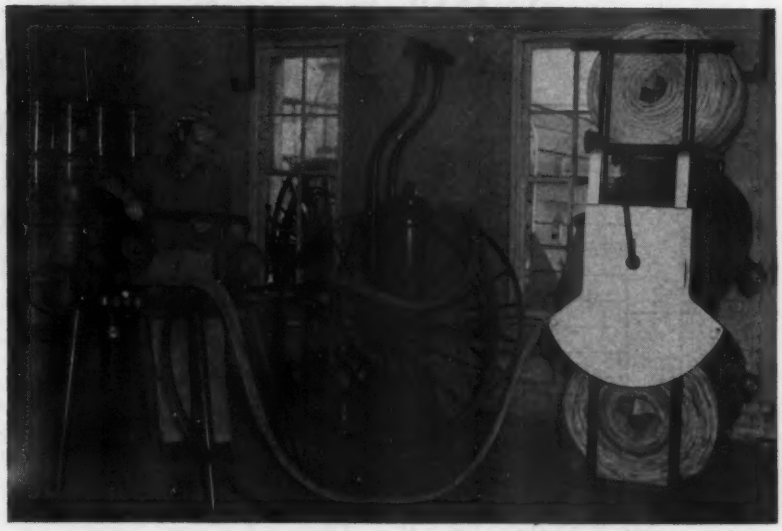
Lion Oil Fire Prevention Establishes Record; Equipment Maintenance Plays Large Part

by C. A. Hardcastle *

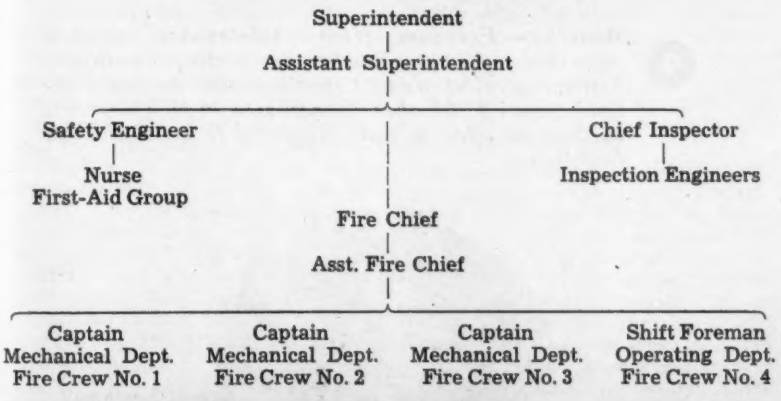
THE proper maintenance of fire-fighting equipment by experienced personnel has enabled Lion Oil Co. to establish a record in the reduction of fires. Since approved equipment is used and maintained in tip-top operating condition, small fires are kept to a minimum and serious blazes are practically nonexistent at this modern refinery.

The Lion Oil fire department has kept pace with the expansion program now in progress at the refinery. The department, which is responsible to the plant superintendent, is organized under a fire chief. An assistant fire chief and three captains head up the fire crews which have been selected from the mechanical department. The night-shift foreman assumes responsibility of the operating-department fire crew in the event of a fire at night until the fire chief reports. The following diagram shows how the fire department is organized:



Hose-coupling expanding tool and hydrostatic test pump are mounted on steel work bench. Special-hose winding mechanism shown at right

FIRE DEPARTMENT ORGANIZATION

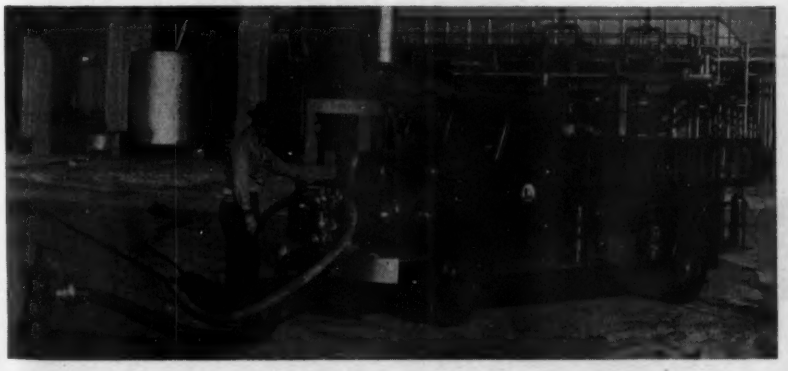


Transportation

Automotive facilities are composed of two trucks, each of which is equipped with a Darley 500-g.p.m. centrifugal water pump and 1,500 ft. of 2½-in. National Standard fire hose. One truck is equipped with a 50-gal. liquid-foam tank which is capable of delivering 10,000 gal. of foam for

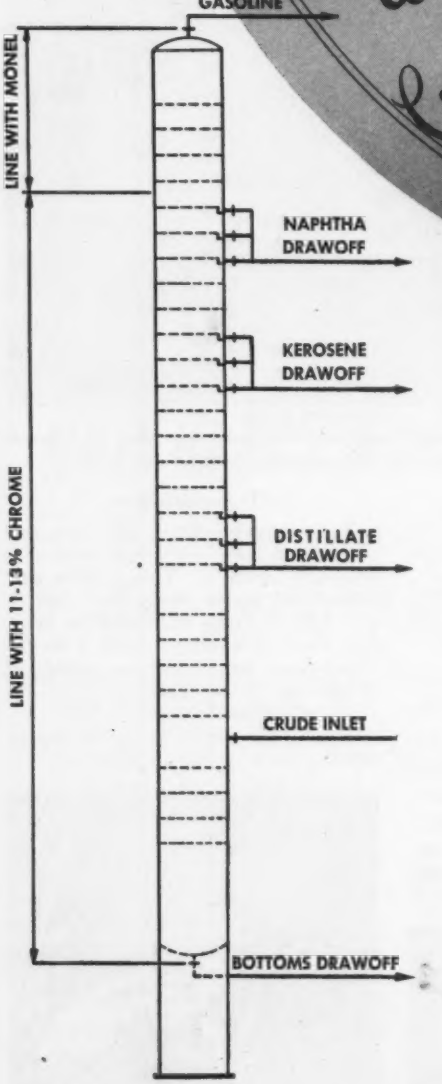
(Continued on page 268)

*Chief inspector, Lion Oil Co., El Dorado, Ark.



Above: Recharging a CO_2-type fire extinguisher. Left: Fire-hose sections and fire nozzles being tested by pumping unit mounted on fire-truck bumper

Rx Our prescription for a trouble-free Crude Fractionating Tower

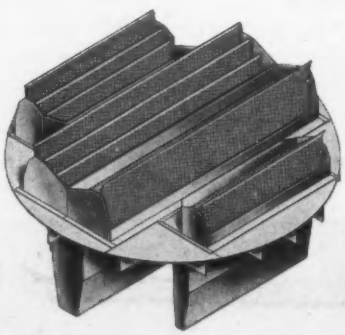


1. *Koch Kaskade Fractionating and Stripping Trays used throughout.*

2. *Koch trays and shell lining of Monel in the upper section of the tower, where acidic water is apt to condense.*

3. *Koch trays and shell lining of 11-13% chrome in the remainder of the tower to withstand corrosion from sulfur compounds and organic acids.*

4. *Benefits — Freedom from maintenance worries, smoother operation under any loading conditions, better control of product specifications, greater overload capacity. All these benefits at 20-25% decrease in total installation cost, compared to a bubble tray installation.*



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OXIDATION INHIBITORS FOR GASOLINE

by Charles D. Lowry, Jr.

THE war necessity of having motor and aviation gasolines which would be unusually stable in storage brought oxidation inhibitors into increased prominence. Shortly after the entry of the United States into the war, the Armed Services came to the petroleum industry with requirements for a new kind of gasoline. It had to be usable in any climate and in any battle area. It had to have quite special boiling range, vapor pressure and knock rating, but particularly, it had to have an extraordinary degree of storage stability. This gasoline had to withstand the blazing sun of the African desert and the sweltering heat of the South Pacific.

High temperature, it is well known, is the factor most detrimental to stored gasoline. This war gasoline had to stand high temperature, not in dumps where it could be protected and shaded—and where it could also be bombed—but in 5-gal. cans strewn helter skelter about the fighting area. Under these conditions, including intermittent exposure to high-temperature days and chilly nights, it had to remain suitable for use for at least 6 months.

The problem of developing such a gasoline was assigned to an industry-wide committee of men experienced in refining, the gasoline additives committee. Accounts of their successful solution of the problem have been presented by Sabina[1] and by Walters.[2] The members of the committee pooled their experience in making gasoline stable under tropical conditions and adopted a tentative specification. Then they sought out the hottest places in the United States where it would be feasible to conduct experiments.

Samples Exposed a Year

Near El Centro and Indio, Calif., were set out in each of 3 consecutive years some 500 5-gal. cans and numerous drums filled with gasoline of all kinds. These samples were left exposed for a year and even longer, testing the gasoline every 3 to 6 months. The results were used to set a final specification, which differed very little from the one tentatively set, and proved entirely satisfactory.

To assure its stability only two things were required of this all-purpose gasoline. It had to have an induction period of at least 8 hours

*See Walters, Reference No. 2.

This article gives an over-all look at the latest thinking on the use of oxidation inhibitors — their "why," "when," and "how." Dr. Lowry is associated with Universal Oil Products Co., Chicago.

and it was required to contain not less and not more than stated concentrations of an approved inhibitor. While inhibitors had been used in motor gasoline for many years prior to this time, never before had they proved so essential.

No gasoline without inhibitor proved adequately stable in these war tests. Even straightrun gasolines, usually considered the ultimate in stability, when leaded and not inhibited, deteriorated so as to be unstable. Acid-treated products, although they could be made to meet the induction-period specification, when uninhibited did not store satisfactorily. On the other hand, the addition of inhibitor, even to some gasolines which had received no more than a sweetening treatment, produced motor fuels which were satisfactory in this drastic service.

The experience with aviation gasoline was similar. On tropical storage, leaded fuels, even straightrun products, would form gum and an objectionable white precipitate. War investigations proved inhibitors essential to the long time stability of any leaded aviation gasoline. They also proved that aviation-gasoline fuel made in part from catalytically cracked gasoline containing some olefins can be made to remain entirely stable under severe conditions with no treatment beyond a caustic wash and addition of inhibitor.

Oxidation inhibitors came into use in the refining of cracked gasoline in the early thirties. Prior to this, drastic acid treatment had usually been employed to make such gasoline storage stable and water white, to make it resemble as much as possible the straightrun gasoline which had previously been the standard of gasoline quality. Realization that such treatment wasted gasoline and chemicals and reduced antiknock value—a property which was establishing cracked gasoline in its own right—and the accustoming of the motor public to colored gasoline through the introduction of tetraethyl lead set the stage for the introduction of inhibitors.

Oxidation inhibitors are needed because cracked gasoline contains olefin, and in lower concentration, diolefin hydrocarbons. When gasoline of this type is stored out of the contact with air it will remain substantially unchanged for many months, but if air is present and, of course, contact with air is unavoidable in the commercial distribution of gasoline, within a short period a process which is part oxidation and in part polymerization converts the olefins, in part at least, into gum. What is more, after starting, this gum formation accelerates on almost a logarithmic scale.

Even a few milligrams of gum per 100 cc. is undesirable and more than about 7 mg. cannot be tolerated. Sulfuric acid or clay treatment removes from gasoline the most reactive of the unstable hydrocarbons, particularly the diolefins, and because there are naturally occurring phenolic bodies, usually termed natural inhibitors, in most gasolines, clay or acid-treated products are often reasonably stable with no additional inhibitor.

Types of Inhibitors

In the early commercial trials in which acid or clay treatment was replaced by addition of inhibitor, a large number of materials were used as antioxidants, among them benzylamino phenol, hydroquinone, catechol, alpha naphthol, and cresol. All of these inhibitors showed deficiencies. Some of them were effective for only a minority of gasolines. Some were extractable by water and particularly by caustic solutions so that they were readily removed from gasoline. Some produced off-color gasolines on storage.

Better compounds were eventually found. At present the butylamino phenols are widely used. N-butylamino phenol was first introduced in admixture with a small amount of butyl phenylene diamine under the designation U.O.P. Inhibitor No. 4. It is very potent, quite resistant to extraction by water, and not greatly harmed by traces of caustic.

Di-sec-butyl-para-phenylene diam-

ine is now the most widely used inhibitor in both motor and aviation gasoline. It was introduced about the beginning of the war as U.O.P. Inhibitor No. 5. It is very effective, is a liquid product, therefore simple to apply, and is completely insoluble in water and caustic, hence, not likely to be accidentally removed from gasoline unless an acid condition should develop. For aviation gasoline two highly substitutted alkylphenols have recently been introduced; 2,4 dimethyl, 6 ter-butyl phenol and 2,6 diterbutyl, 4 methyl phenol. These products are free from any tendency to autoxidation, are resistant to extraction, and gave satisfactory results in wartime storage tests. These inhibitors must be used commercially for a considerable time to show that they are as satisfactory from all standpoints as the mentioned diamine.

Effectiveness of inhibitors is judged in the final analysis by whether they can keep gasoline from deteriorating in storage. But as storage tests cannot be made on every sample of gasoline, it is essential to be able to predict as accurately as possible the behavior of gasoline in storage from accelerated tests. A number of tests are in current use, no one of which by itself is entirely satisfactory. Nor indeed is it easy to set up any simple combination of tests which will be unfailingly accurate.

Conclusions drawn from accelerated tests must be tempered by experience. In a gasoline free from inhibiting substances, the first change which can be noted in storage is the formation of peroxides, which may be detected by delicate tests within a few days after production. Following the peroxide buildup gives a good picture of the rate of change of the gasoline. In uninhibited gasoline the increase is almost logarithmic. In the presence of an inhibitor, peroxide formation is repressed and does not reach a high value until the inhibitor has been used up. When peroxide concentration reaches about two equivalents of active oxygen per 1,000 l., usually gum begins to form and this gum, if separated, will be found to be highly peroxidic.

Induction-Period Tests

The most commonly made test for effectiveness of an inhibitor is the induction period. An unsaturated gasoline free from inhibiting substances, when exposed to oxygen and high temperature (the usual conditions are 212° F. and 100 lb. oxygen pressure), begins to absorb oxygen almost immediately. If the gasoline contains natural inhibitors, it will take up oxygen somewhat more slowly. If one of the more effective synthetic inhibitors is used, oxygen absorption will be almost undetectable for a considerable length of time. When oxygen begins to be absorbed, there is a marked change in the slope of the oxygen-absorption curve, a point termed the break.

The time from the beginning of heating to the break is the induction period. In gasolines which do not contain natural inhibitors (and this was the case with the war gasolines, because they were low boiling) and in which a dependable inhibitor is used, the induction period is a fairly accurate measure of the length of time the gasoline will remain free of gum in storage.

In the presence of natural inhibitors, predictions from the induction period alone are not reliable. The natural inhibitors, which are mostly cresol and xylenols, are not effective except in gasolines of high inhibitor susceptibility. In acid or clay-treated gasolines, and possibly in some low-bromine-number catalytically cracked products, a long induction period which is due to a natural inhibitor means fair stability, although the same induction period with a good synthetic inhibitor will mean a longer storage life.

Natural inhibitors are not effective in usual thermally cracked gasolines, for example, unless these have been clay or acid treated. Thermal gasolines are sometimes encountered which have induction periods of as much as 1,000 minutes and yet are gum stable in storage for less than a month. In the presence of natural inhibitors the induction period is not a reliable measure of storage stability, and therefore, gasoline specifications including an induction period as the only measure of storage stability are inadequate and dangerous. The increase in induction period produced by a synthetic inhibitor is more closely related to the storage life than the induction period itself.

Copper-dish gum content is an old and widely used property of gasoline which is markedly affected by inhibitors. A cracked gasoline of normal boiling range normally has a fairly high copper-dish gum value. This high value has no bearing on the stability of the gasoline for immediate use, but may be related to its storage stability. By addition of inhibitor, the induction period is increased and the copper-dish gum usually reduced to a low value.

While natural inhibitors increase induction period, they do not usually greatly reduce copper-dish gum. A long induction period coupled with a low-copper-dish gum is, therefore, fairly good indication that a gasoline has been properly inhibited. However, some otherwise satisfactory inhibitors do not always reduce copper-dish gum to a low value. Nor are copper gum values very significant if the gasoline is low boiling or allowed to evaporate very rapidly. For these reasons and because it is difficult to obtain reproducible copper-dish gums, it is of questionable value as a part of sales specification. Determination of copper-dish gum can be very helpful, however, as a manufacturing control. When an inhibitor does not reduce this property it usually means that something is lacking in the treating procedure. There may be an excessive concentration of natural inhibitors, the gasoline may have been stored and become peroxidized, it may contain copper, or may have been doctor sweetened with the use of excess sulfur. Seeking the reason for the high copper-dish gum value may produce better operating control of the treating plant.

Predicting Storage Life

Because of the deficiencies in the use of induction period and copper-dish gum as criteria of storage stability, some laboratories have given a great deal of study to the rate of gum formation during the induction period and developed so-called gum-time tests. Walters and coworkers[1-4] have published extensively in this field. Usually the gasoline is oxidized for a definite period, cooled quickly, and the gum content is determined. A series of gum tests may be made after definite and increasing periods of oxidation. Tests are also made at different oxygen pressures and different temperatures and extrapolation made to conditions of normal storage.

While it has not always been possible to predict the exact storage life from gum-time tests, they are very valuable. The gum-time test values are useful in measuring the efficiency of inhibitor protection, particularly because natural inhibitors, as a rule, do not show up well in gum-time work. The test, therefore, differentiates between inadequately inhibited samples which nevertheless have high induction periods and those which are properly inhibited. Gum-time tests proved accurate in the wartime desert-storage work. There were very few cases in which a gasoline predicted stable by either induction period or gum time proved unsatisfactory in these tests.*

Aviation gasoline, if it contains unsaturated components such as catalytically cracked base stock, is inhibited for gum stability. It is also inhibited whether or not it contains unsaturated compounds to prevent lead deposition. As aviation gasolines are, as a rule, not more than slightly unsaturated, determinations of induction period normally cannot be made. The usual test is to expose the gasoline to accelerated oxidation at 212° F. and 100 lb. oxygen pressure and then measure the amount of precipitate formed and the amount of residue remaining on evaporation of the gasoline. When the accpted inhibitors are used, usually only a negligible amount of precipitate or gum is formed even after 16 hours' oxidation. Stability of aviation gasoline for a year even under severe conditions is not difficult to obtain.

A problem which is attracting con-

*See Walters, Reference No. 2.

siderable attention at the present time is the inhibiting of catalytic gasoline for use in motor fuel. Low-boiling, low-sulfur catalytic fractions of comparatively low olefin content, such as were used during the war for aviation base stock are readily made storage stable by the use of inhibitors. When higher-boiling, more-unsaturated catalytic stocks became available, they were found to have long induction periods and, therefore, were judged to be stable even without the addition of inhibitor. This probably is the case in some instances, but the phenolic bodies or natural inhibitors producing the long induction periods do not always produce storage stability, and in high concentration appear to encourage engine fouling.

Some Stocks Gum

Particularly troublesome are catalytically cracked stocks of high sulfur content and high bromine number. Some of these form gum in a few weeks' time when not inhibited, and are very difficult to inhibit. In many cases a caustic wash removing phenolic bodies greatly improves stability and inhibitor effectiveness. Whether by proper caustic washing all catalytic gasolines can be made storage stable by use of inhibitor without acid treatment is still an undecided question.

A question which everyone who has dealt with inhibitors has thought about a good deal, is, just why is an inhibitor? What is the mechanism of its action? For inhibitors are rather remarkable compounds. Less than 1 part in 20,000 of gasoline is often able to hold stable for a year's storage, a gasoline which without inhibitor would be unfit for use within a month. How is such action possible? Imagine a policeman trying to control 20,000 lively boys. If he could get them all in a single line and sufficiently cowed, so that only an occasional boy would break ranks, he could control the delinquents and keep some semblance of order.

Molecules, even the reactive olefins of some cracked gasolines, which are eager to consort with the surrounding oxygen molecules, are much like the small boys. Not all of them react at once. Only a few get out of line, or as the physical chemist says, become activated in any given time interval. An active molecule starts a chain reaction, and in each chain a succession of molecules undergoes change. These active molecules, like the unruly boys, by their example, invite others to step out of line, and if uncontrolled, reaction will soon be going on at a lively rate.

In gasoline, the activated molecules apparently form peroxides and if not interfered with, these peroxides have a catalytic action so that reaction accelerates and then gum forms. The inhibitor reacts with the peroxides when they are first formed, breaks the reaction chains, and by so doing prevents significant change in the gasoline.

One more comparison with the policeman and the boys. The more lively and alert the policeman is and the more quickly he represses incipient rebellion, the better order he will keep. Among chemical policemen, the alertness of an inhibitor is measured by its oxidation potential. The lower the potential of a compound, the more quickly it reacts with peroxide and the better its inhibiting action, other things being equal. In practice, compounds of low oxidation potential are usually the best inhibitors.

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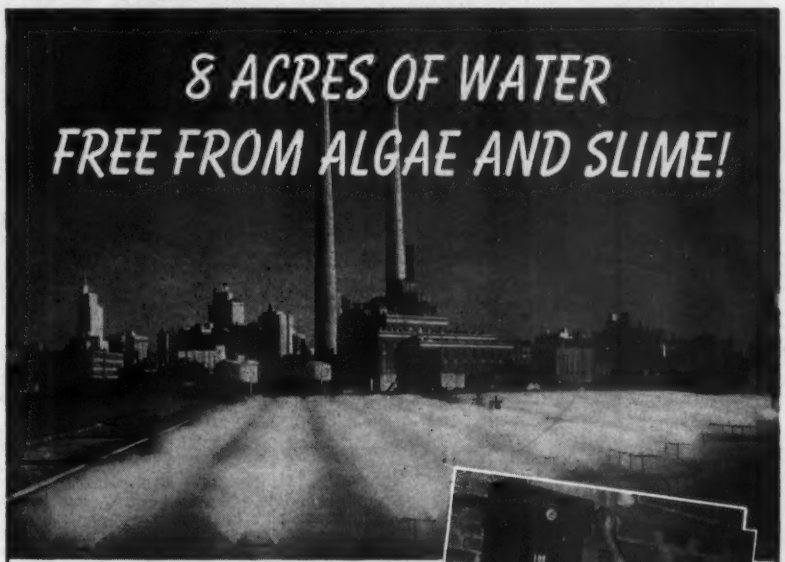

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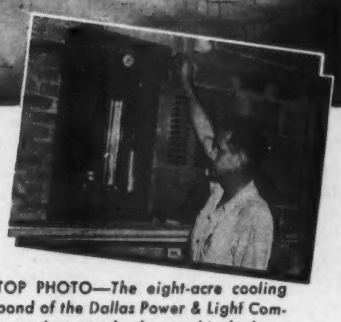

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LOWER PHOTO—*A. D. P. & L. plant engineer adjusts the control valve of the Paddock High-Capacity Chlorinator which serves the big cooling pond.*

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Venting Requirements of Standard Cone-Roof-Type Oil-Storage Tanks

*by Thomas M. Babin**

FREQUENTLY, oil storage tanks are installed with little attention being given to venting requirements. After the tanks are in service, pumping rates may be increased from time to time with no attention being given to increasing the venting capacity. Failures of tank roofs have occurred because of the inadequacy of vents for conditions of operation, and although the tank damage is usually not great in such failures, it is in most cases, necessary that the tank be removed from service for repairs.

Removal of a tank from service means loss of storage capacity which at times may necessitate the slowdown or complete stoppage of a refining unit. In addition, the cost of removing a tank from service for cleaning, steaming, etc., in preparation for repairs, and its subsequent return to service usually amounts to a sizable expenditure. At present, a cleaning operation for 80,000-bbl.-capacity crude tanks in one refinery exceeds $2,000 per vessel.

It has been found important to check venting capacity often in view of the frequent increases in pumping rates in and out of various tanks. The following method of determining venting requirements was especially designed for checking venting capacity of tanks already in operation but it may just as well be used for new installations. The method was developed for the maximum breathing to be expected in the Baytown refinery of Humble Oil & Refining Co. for stocks normally stored in atmospheric cone-roof-type tanks constructed in accordance with A.P.I. Standards 12A or 12C (or equivalent).†

*Maintenance-engineering and inspection department, Humble Oil & Refining Co., Baytown, Tex.

Factors Involved in Breathing

There are two separate mechanisms by which the influx of air or discharge of tank vapors may occur. These mechanisms may occur simultaneously or one may occur to the exclusion of the other. As applied to fixed-volume atmospheric tanks they are described as follows:‡

Pumping displacement—As oil is pumped into a tank an equal volume of vapors is forced out of the tank vents. Likewise air will flow into a tank at a rate equivalent to the outpumping rate.

hydrocarbon vapors are evolved during a period of tank vapor-space temperature rise and air is drawn into the tank during a period of temperature decrease. The discharge of vapor from the tank is the combined result of the expansion of the vapors resulting from the temperature change and the vaporization of oil resulting from the change in equilibrium conditions. Air inflow is effected by contraction and condensation of vapors caused by a temperature reduction.

Thermal displacement—Mixed air-

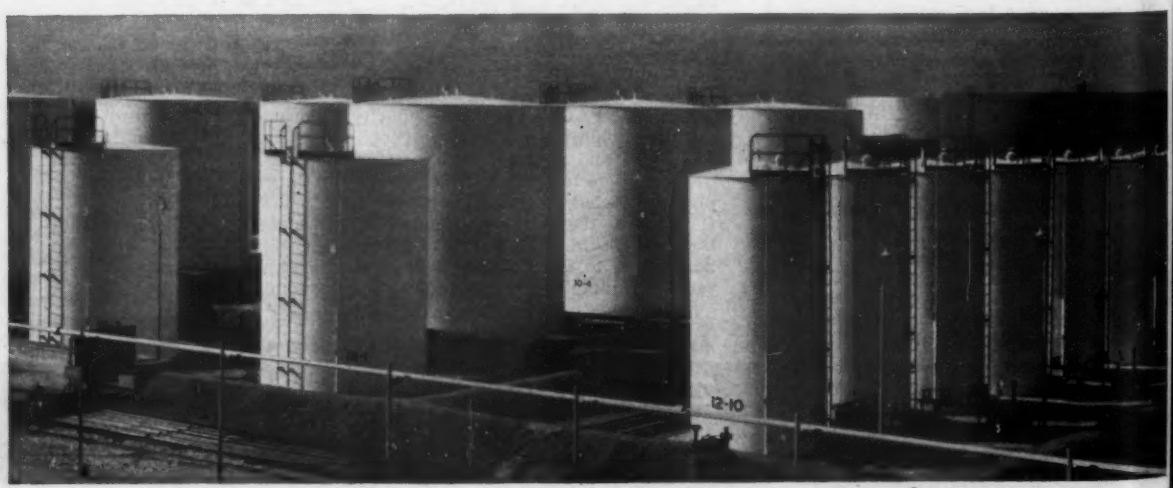
Thermal breathing is governed by the vapor pressure of the liquid stored, the volume of the vapor space, the rates of temperature change of the tank vapor space and the liquid surface. For a given liquid vapor pressure and pumping rate, the highest rate of thermal breathing will take place under the combined conditions of maximum vapor space (i.e., tank almost empty) and maximum vapor-space temperature rise or drop.

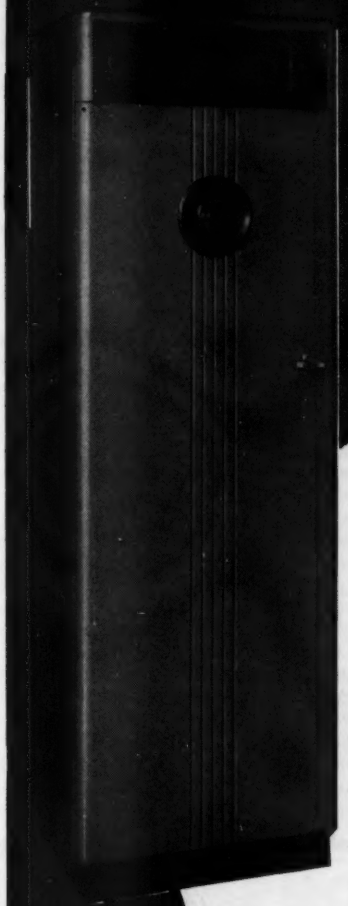
Maximum Venting Conditions

The maximum condition of pressure venting is produced by the most rapid rise in the vapor-space temperature at the same time that the almost empty tank is being filled at the maximum rate. For maximum vacuum displacement the most severe combination of adverse conditions is represented by a rapid drop of the vapor-space temperature in an almost empty tank which is being emptied at the maximum rate. In venting calculations numerical values must therefore be determined for the expected maximum temperature changes. Giv-

†Due to inbreathing and outbreathing it is impossible to prevent the presence of explosive mixtures in tank vapor spaces, and past experience has shown that explosions and fires sometimes occur in tanks of this type. Such occurrences are relatively rare, however, and it is deemed impractical to provide venting for such emergencies. Safety seams are provided to protect the tanks from extensive damage in emergencies, and the breather valves are only to accommodate maximum normal changes in vapor space conditions.

‡The vapor efflux due to boiling has been omitted purposely because this factor must be considered only in the case of stocks with vapor pressures above atmospheric, for which cone-roof tanks are not ordinarily considered satisfactory.





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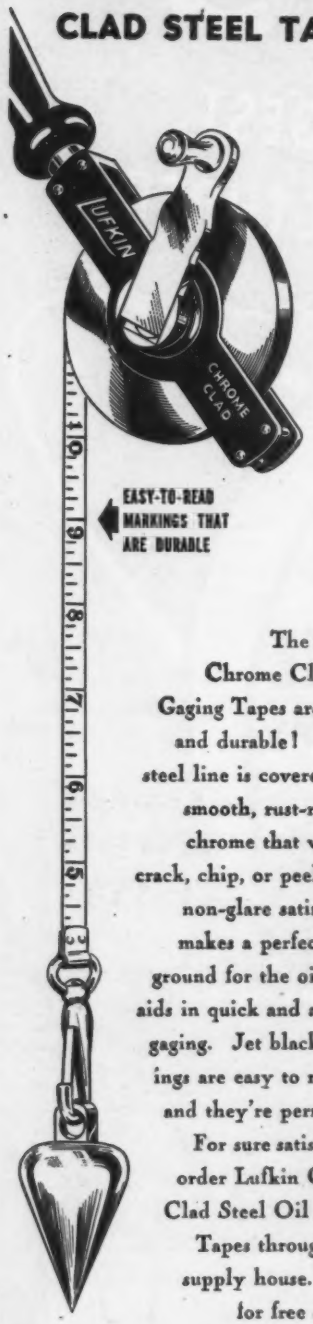

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en this temperature change, the volumetric variation of the vapors may be ascertained with a satisfactory approximation by application of Charles' law.*

Although it is realized that for a given condition actual venting requirements will decrease with decreased vapor pressures, the method herein described is based on the highest vapor-pressure liquid to be stored in such tanks. This assumption is deemed necessary since it is not uncommon to change the service of storage tanks without consideration being given to venting requirements.

It has become general practice to install conservation vents on tanks which will contain the more volatile stocks and gooseneck or other open-type vents on tanks containing less-volatile stocks. The conservation vents that have been adopted are the 6 and 8-in. sizes with 0.5 oz. per per. sq. in. pressure disk and 0.2 oz. per sq. in. vacuum disk. The gooseneck vents used are 6 and 8-in. i.d. cast iron with integral flange for connecting to nozzles on the tank roof. These vents have proved satisfactory in the past years and it is planned to limit future selections to these sizes and types.

Conservation vents are generally used when the closed-cup flash point of the stock is less than 150° F. Gooseneck vents are generally used for stocks with a closed cup flash point above 150° F. This, however, is not made a hard and fast rule, since there are circumstances which will alter the selection. In this connection it must be ascertained whether the tank will be subjected to changes in stocks which may have flash points below 150° F. Conservation vents are provided in the majority of cases for tanks which are subject to such variation in service.

All conservation vents are provided with a two-mesh wire screen on the discharge flange to prevent the entrance of birds. Screens are not used on gooseneck vents.

The available capacity of venting equipment must be known for the determination of the number and size of units required in any problem of tank venting. The capacity of a gooseneck vent may be calculated if the pressure drop and density of the vapors are known by the application of empirical formulas which may be found in engineering flow data publications. Venting capacities of conservation vents are a function not only of these factors, but also of pressure (or vacuum) setting. The capacities of conservation vents may be determined from curves and/or tables furnished by manufacturers of such devices. Capacities of conservation vents are given in volumes of standard air; therefore, for pressure venting of vapors from a tank it is necessary to take into consideration the effect of density. The flow capacity of vents for gases other than air is inversely proportional to the square root of the density of such gases. The density will always be greater than 1 in cases of tank venting; therefore, it is seen that the vent capacity for these vapors will be less than the vent capacity for air.

Since breathing capacities will be governed by the length of pipe between the vent and tank in an actual installation, the vent should be installed directly above tank nozzles.

Venting equipment should be chosen so that sufficient capacities are available at designated pressures and vacuums which will definitely eliminate any possibility of damage to the tank. On the pressure side, it is important to avoid the lifting of the roof plates from the rafters on account of excessive tank pressure, as this may lead to the development of leaks in the seams and joints. The $\frac{3}{16}$-in. roof plates used in standard tank construction (A.P.I. Standards 12A and 12C) weigh approximately 0.85 oz. per sq. in., which is equivalent to 1.5 in. of water. It is generally agreed that the large-diameter tanks will withstand a pressure of 3-in. of water before roof failure. If the venting equipment is selected according to the capacity available at 1.5 in.

*Charles' law is applicable specifically to perfect gases and as such is not absolutely correct in cases of tank venting. It will, however, give results which are sufficiently accurate.

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of water, there will be an ample margin of safety to protect against rupture of the roof. On the vacuum side a sufficient margin of safety must be allowed to protect the tank from collapsing or buckling under excessive vacuum. The collapse will be retarded by the stiffening action of the top angle, the roof and the roof rafters. The vacuum capacity of the vents is selected at 1.5 in. of water vacuum.

Calculating Venting Requirements

In arriving at a simple method for determining venting requirements it is felt that the largest possible range of operating conditions should be considered. This is desirable if flexibility and safety are to be achieved.

Accordingly the method is based on the following assumptions:

1. For pressure, the required breathing capacity is taken as the sum of the thermal pressure breathing for an empty tank (free of liquid) due to the volumetric change resulting from the highest rate of temperature rise and the breathing due to pumping in at the maximum rate. The maximum vapor space temperature rise is assumed to be 20° F. per hour for 140,000-bbl. tanks varying to 50° F. per hour for 6,000-bbl. tanks. Vaporization due to liquid surface temperature change is assumed to be equal to 50 per cent of the numerical value of thermal pressure breathing.

2. For vacuum, the required capacity is taken as the sum of the thermal vacuum breathing for the empty tank due to the highest rate of temperature drop, and the displacement resulting from the maximum outpumping rate. The maximum vapor space temperature drops are assumed to vary from 30° F. per hour for 140,000-bbl. tanks to 70° F. per hour for 6,000-bbl. tanks. Condensation at the liquid surface is assumed to be equal to 50 per cent of the numerical value of thermal vacuum breathing.

3. The vapor space is assumed to contain 100 per cent hydrocarbon with a specific gravity of 2.25 and the vent capacities are reduced to allow for same as of pressure venting.

Calculations indicate that the most adverse condition results from pressure breathing. This is due to the reduction in vent capacity for pressure venting to allow for the effect of density on vent capacity.

Breathing capacity requirements determined from the above assumptions correspond to the most severe combination of adverse conditions and the probability that these may ever be realized is remote.

With the foregoing assumptions the following factors are pertinent for every study of breather requirements:

1. The flash point of the stock.

The flash point will be necessary only to determine whether gooseneck vents or conservation vents are to be provided. As previously discussed, gooseneck vents are generally used when the flash point of the stock is above 150° F.

2. Tank size.

3. Maximum pumping rates.

Formulas

To further simplify tank venting calculations the following formulas are used:

1. Maximum pumping breathing required in cubic feet per hour.

$Qp = 8.4R$

where

R = Max. pumping rate in barrels per hour. (The figure 8.4 is the product of 1.5 and 5.6. The figure 5.6 is the number of cubic feet per 42-gal. barrel. To correct for density the figure 1.5 is applied. This correction factor corresponds to a density of 2.25).

2. Maximum thermal breathing required in cubic feet per hour.

$Qt = 1.5\ d(d + 3h)$

where

d = tank diameter in feet

h = tank height in feet

(1.5 as before is a density correction factor. The expression $d(d + 3h)$ is a relation which gives results corresponding to the previous assumptions.

3. Total required venting capacity.

$Q = Qp + Qt$

or $Q = 8.4R + 1.5d(d + 3h)$

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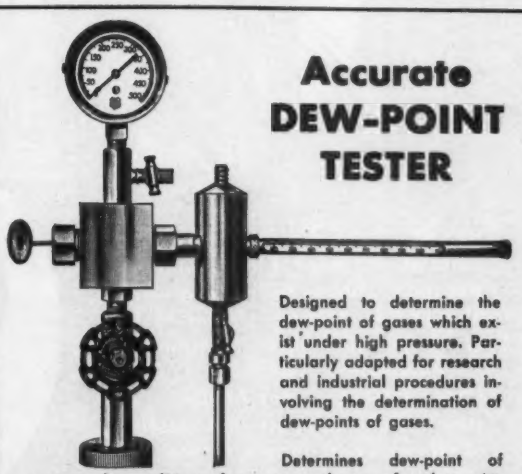

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Expansion Under Way Will Boost Crude Charging Capacity to 6,000,000 Bbl. Daily

by R. B. Tuttle

LISTED here are the major refinery-expansion projects, which when completed, will boost the industry's capacity ratings to well over 6 million barrels per day of crude-oil charge. Although many of the projects listed are not scheduled for completion this year, the capacity figures on crude-oil charging rates by the year's end are expected to exceed 6,000,000 bbl. per day.

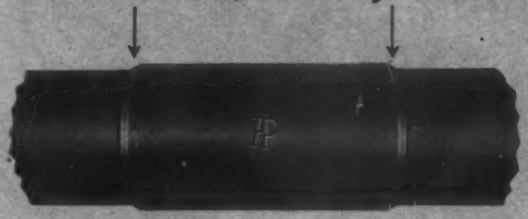
A number of new catalytic cracking units, now building and authorized for construction, will increase appreciably the industry's capacity on that type of process within the next few years. Several plants for the preparation of lube stocks and for the manufacture of lubricating oils are scheduled to be ready for operation within a similar period.

Also included in the list are various other projects which were reported to The Oil and Gas Journal by operating, engineering, and construction companies engaged in these respective industries. Compiled from information obtained in a survey directed to the different companies, the list includes the latest information.

PLANT-CONSTRUCTION PROJECTS

Company, location and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Aetna Oil Co., Louisville:				
Storage, bbl.	47,000	Building	Mid '48	Chicago Bridge & Iron Co.
American Liberty Oil Co., Mount Pleasant, Tex.:				
Polymerization unit, bbl. per day	173	Building	June '48	
L.P.G. manufacturing facilities, bbl. per day	211	Building	June '48	
Atlantic Refining Co., Philadelphia:				
Synthetic-detergent manufacture, bbl. per day	75,000	Building	Early '48	None
Propane, dewaxing plant, bbl. per day	2,500	Building	Early '48	E. B. Badger & Sons Co.
Lube plant, bbl. per day	1,300	Building	Mid '48	E. B. Badger & Sons Co.
Wax-plant addition, tons per day	155	Building	1948	The Lummus Co.-The M. W. Kellogg Co.
Steam-generating-plant extension, lb. per hour	150,000	Building	Early '48	The Babcock & Wilcox Co.
Atlantic Refining Co., Port Arthur, Tex.:				
Refining-capacity increase, bbl. per day	15,000	Planned	1948	
Atomic Producing & Refining Co., Albany, Ky.:				
TEL plant		Planned	1948	
Additional storage		Planned	1948	
Bareco Oil Co., Wichita:				
Perco desulfurization-reforming, bbl. per day	4,000	Building	Mid '48	Koch Engineering Co., Inc.
Berry Asphalt Co., Waterloo, Ark.:				
Vacuum lube unit, bbl. per day	1,200	Building	Mid '48	Process Engineers, Inc.
Berry Asphalt Co., Stephens, Ark.:				
Plant expansion		Planned		
British-American Oil Co., Ltd., Port Moody, Canada:				
New refinery		Planned		
British American Oil Co., Ltd., Montreal:				
Fluid cat. cracking unit, bbl. per day	13,500	Authorized	Late '49	The M. W. Kellogg Co.
Cat. polymerization unit, bbl. per day	500	Authorized	Late '49	The M. W. Kellogg Co.
Crude-distillation unit, bbl. per day	14,500	Authorized	Late '49	The M. W. Kellogg Co.
Cat. polymerization unit, bbl. per day	200	Building	Mid '48	Koch Engineering Co., Inc.
L.P.G. unit, bbl. per day	200	Building	Mid '48	Koch Engineering Co., Inc.
Calumet Refining Co., Princeton, La.:				
Remodeling distillation equipment		Building	1948	
Steam-generating plant		Building	1948	
Additional storage		Building	1948	
Carter Oil Co., Billings, Mont.:				
New refinery, bbl. per day	20,000	Building	Late '49	Fluor Corp.
Carthage Hydrocol, Inc., Brownsville, Tex.:				
Gas-producing plant, cu. ft. per day	64,000,000	Building	Late '48	Arthur G. McKee & Co.
Champlin Refining Co., Enid, Okla.:				
Phenol-extraction plant, bbl. per day	700	Building	Early '48	Koch Engineering Co., Inc.
Catalytic cracking unit		Considered		
Crude still		Considered		
Citcon Corp., Lake Charles, La.:				
Lube-oil plant, bbl. per day	6,000	Building	Late '48	The Lummus Co.-Max B. Miller
Cities Service Oil Co. (Del.), East Chicago, Ind.:				
Plant modernization		Building	Late '48	The M. W. Kellogg Co.
Continental Oil Co., Billings, Mont.:				
New refinery, bbl. per day	6,800	Building	Mid '48	Jones & Laughlin Supply Co.
Continental Oil Co., Denver:				
Increasing crude capacity to bbl. per day	6,750	Building	Late '48	
Installing catalytic cracking unit		Building	Late '48	
Installing catalytic polymerization unit		Building	Late '48	
Continental Oil Co., Ponca City, Okla.:				
Modernize refinery		Planned	1948	
Cooperative Refinery Association, Coffeyville, Kans.:				
M.E.K. dewaxing unit, bbl. per day	2,500	Building	Late '48	Process Engineers, Inc.
Cosden Petroleum Corp., Big Spring, Tex.:				
Cat. cracking unit, bbl. per day	5,500	Considered		
Derby Oil Co., Wichita:				
Propane-recovery unit		Building	Early '48	
Asphalt-packaging plant		Building	Early '48	
Dewese Oil Refinery, Weston, Ohio:				
Lube-oil filtering equipment		Building	1948	
Desalting facilities		Building	1948	

Joints Are Always Tight



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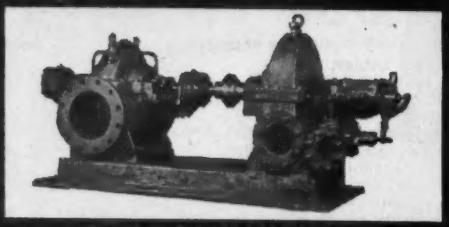

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PLANT-CONSTRUCTION PROJECTS (Continued)

Company, location and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Elk Refining Co., Falling Rock, W. Va.:				
Crude-oil still	.....	Building	Early '48	.....
Empire Petroleum Co., Denver, Colo.:				
Crude-oil distillation unit, bbl. per day	3,000	Planned	.....	.....
Additional storage tanks, bbl.	100,000	Planned	.....	.....
Asphalt storage warehouse	.....	Planned	.....	.....
Esso Standard Oil Co., Baton Rouge, La.:				
Expanding catalytic cracking unit, bbl. per day	12,200	Building	Early '48	E. B. Badger & Sons Co
			Early '48	The M. W. Kellogg Co.
Atmospheric distillation unit, bbl. per day	58,000	Building	Early '48	Arthur G. McKee & Co.
Polymerization unit, bbl. per day	2,600	Building	Early '48	C. F. Braun Co.
Esso Standard Oil Co., Baltimore, Md.:				
Modernization of grease plant and reconstruct vacuum unit	.....	Building	.....	.....
Esso Standard Oil Co., Linden, N. J.:				
Catalytic cracking unit, bbl. per day	.....	Building	Early '49	C. F. Braun Co.
Vacuum distillation unit, bbl. per day	.....	Building	Early '49	C. F. Braun Co.
Fen Ter Refining Co., Wynnewood, Okla.:				
Asphalt unit	.....	Planned	.....	.....
General Petroleum Corp., Torrance, Calif.:				
Revamping crude unit, bbl. per day	32,000	Authorized	Mid '48	C. F. Braun Co.
Gulf Oil Corp., Philadelphia:				
Vacuum unit, bbl. per day	12,000	Building	.....	The Lummus Co.
Naphtha polyform unit	.....	Building	.....	The Lummus Co.
Gulf Oil Corp., Port Arthur, Tex.:				
Three topping and vacuum units, bbl. per day	66,000	Building	Mid '48	E. B. Badger & Sons Co.
Catalytic desulfurization unit, bbl. per day	17,000	Building	Mid '48	The Lummus Co.
Naphtha polyform unit	.....	.....	.....	.....
Gulf Refining Co., Cincinnati:				
Catalytic cracking unit, bbl. per day	15,000	Building	Mid '49	The M. W. Kellogg Co.
Polymerization unit	.....	.....	.....	.....
Gulf Refining Co., Toledo:				
Topping and vacuum unit, bbl. per day	32,000	Building	Oct. '48	E. B. Badger & Sons Co.
Catalytic cracking unit, bbl. per day	15,500	Building	May '49	.....
Polymerization unit	.....	.....	May '49	The M. W. Kellogg Co.
Humble Oil & Refining Co., Baytown, Tex.:				
Lube plant, bbl. per day	4,600	Building	Early '48	E. B. Badger & Sons Co.
Husky Refining Co., Lloydminster, Canada:				
Capacity increase, bbl. per day	5,000	Planned	.....	.....
Imperial Oil, Ltd., Edmonton, Canada:				
New refinery, bbl. per day	6,000	Building	Mid '48	.....
Imperial Oil, Ltd., Montreal:				
Fluid cat. cracking unit, bbl. per day	11,000	Building	.....	.....
Cat. polymerization unit, bbl. per day	4,200	Building	.....	.....
Enlarge crude unit, bbl. per day	5,000	Building	.....	.....
Kanotex Refining Co., Arkansas City, Kans.:				
Perco resulfurization-reforming, bbl. per day	4,200	Building	Mid '48	Koch Engineering Co., Inc.
Lakeside Refining Co., Kalamazoo, Mich.:				
Additional storage, bbl.	25,000	Building	Early '48	.....
Magnolia Petroleum Co., Beaumont, Tex.:				
Dewaxing unit, bbl. per day	4,500	Building	.....	.....
Solvent-extraction unit, bbl. per day	3,500	Building	.....	.....
Crude still, bbl. per day	6,500	Building	.....	.....
Vacuum unit, bbl. per day	10,000	Building	.....	.....
McMurrey Refining Co., Tyler, Tex.:				
Polymerization unit	.....	Building	1948	.....
MFA Oil Co. (Ref. Div.), Chanute, Kans.:				
Desulfurization facilities	.....	Planned	1948	.....
Mid-Continent Petroleum Corp., West Tulsa:				
Fluid cat. cracking unit, bbl. per day	15,000	Building	Late '48	The M. W. Kellogg Co.
Midland Co-op Wholesale, (Cushing Ref. Div.), Cushing, Okla.:				
Increase thermal cracking facilities	.....	Considered	.....	.....
Monarch Refineries, Inc., Oklahoma City:				
Vacuum lube unit	.....	Planned	.....	.....
National Cooperative Refinery Association, McPherson, Kans.:				
Perco desulfurization-reforming, bbl. per day	5,000	Building	Early '48	Koch Engineering Co., Inc.
North Star Refining Co., Shelby, Mont.:				
Moving refinery, bbl. per day	.....	Planned	.....	.....
Ohio Oil Co., Robinson, Ill.:				
Fluid cat. cracking unit, bbl. per day	12,400	Building	1948	
Atmospheric and vacuum unit, bbl. per day	25,000	Building	1948	
Catalytic polymerization unit, bbl. per day	3,800	Building	1948	
Steam-generator extension, lb. per hour	120,000	Building	1948	Arthur G. McKee & Co., Universal Oil Products Co., J. F. Pritchard & Co.
Electric-generator extension, kw.	10,000	Building	1948	
Asphalt oxidizing unit	.....	Building	1948	
Gas-recovery unit	.....	Building	1948	
Gasoline-treating unit	.....	Building	1948	.....
Paraffine Cos., The, Inc., Emeryville, Calif.:				
Two asphalt stills, bbl.	720	Building	.....	.....
Superheater for stills	.....	Building	.....	.....
Petco Corp., Blue Island, Ill.:				
Reforming unit	.....	Considered	.....	.....
Petco Corp., Marrero, La.:				
Refinery expansion	.....	Planned	1948	.....
Phillips Petroleum Co., Kansas City, Kans.:				
Catalytic cracking unit	.....	Authorized	.....	.....
Catalytic polymerization unit	.....	Authorized	.....	.....
Producers Refinery, Inc., West Branch, Mich.:				
Refinery expansion, bbl. per day	1,500	Planned	1948	.....
Pure Oil Co., Nederland, Tex.:				
Lube unit	.....	Building	.....	.....

TULSA TYPE

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- Natural Gasoline Plants
- Steel Plate Fabrication
- Structural Steel
- Warehouse Steel

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PLANT-CONSTRUCTION PROJECTS (Continued)

Company, location and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Pure Oil Co., Newark, Ohio:				
Fluid cat. cracking unit, bbl. per day	5,000	Building	.....	.....
Radio Oil Refineries, Ltd., East Kildonan, Canada:				
Capacity increase, bbl. per day	1,000	Building	Early '48	.....
Rock Island Refining Corp., Indianapolis:				
Catalytic cracking unit	.....	Planned	.....	.....
Capacity increase, crude unit, bbl. per day	1,000	Planned	.....	.....
Root Petroleum Co., El Dorado, Ark.:				
Topping heater	.....	Building	.....	.....
Shamrock Oil & Gas Corp., Sunray, Tex.:				
Capacity increase, crude unit, bbl. per day	2,200	Planned	.....	.....
Shell Oil Co., Inc., Wilmington and Martinez, Calif.:				
Extensions (motor lab., insecticide, and absorption plants)	.....	Building	Mid '48	Shell, Bechtel Corp., Ralph M. Parsons Co.
Shell Oil Co., Inc., Houston:				
Lube plant, bbl. per day	2,800	Building	Mid '48	The Lummus Co., The M. W. Kellogg Co., Fluor Corp.
Shell Oil Co., Inc., Norco, La.:				
Fractionator, bbl. per day	12,000	Building	Mid '48	None
Cracked asphalt plant, tons per year	30,000	Building	Early '48	None
Sinclair Refining Co., East Chicago, Ind.:				
Fluid cat. cracking unit, bbl. per day	25,000	Building	Early '48	C. F. Braun Co.
Lube-treating plant, bbl. per day	2,500	Building	Mid '48	The Lummus Co.
Polymerization unit	.....	Building	Early '48	C. F. Braun Co.
Crude unit, bbl. per day	30,000	Building	Mid '48	C. F. Braun Co.
Sinclair Refining Co., Marcus Hook, Pa.:				
Fluid cat. cracking unit, bbl. per day	25,000	Building	Early '48	C. F. Braun Co.
Polymerization unit	.....	Building	Early '48	C. F. Braun Co.
Vacuum unit, bbl. per day	24,000	Building	Early '48	C. F. Braun Co.
Sinclair Refining Co., Houston:				
Crude unit, bbl. per day	30,000	Building	Early '48	The Fluor Corp., Ltd.
Grease works and barrel house	.....	Building	Mid '48	The Fluor Corp., Ltd.
Skelly Oil Co., Eldorado, Kans.:				
Additional solvent-manufacturing facilities	.....	Planned	.....	.....
Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.:				
Crude unit	.....	Building	Early '48	E. B. Badger & Sons Co.-The Lummus Co.
Lube unit	.....	Building	.....	E. B. Badger & Sons Co.
Socony-Vacuum Oil Co., Inc., Casper, Wyo.:				
Cat. cracking unit, bbl. per day	8,000	Building	Early '49	.....
Socony-Vacuum Oil Co., Inc., East St. Louis, Ill.:				
Refinery expansion	.....	Planned	Early '49	.....
Socony-Vacuum Oil Co., Inc., Augusta, Kans.:				
Cat. cracking unit, bbl. per day	10,000	Planned	Early '49	.....
Southwestern Oil & Refining Co., Corpus Christi, Tex.:				
Cat. cracking unit, bbl. per day	5,000	Building	Mid '48	Process Engineers, Inc.
Standard Oil Co. of British Columbia, North Burnaby, B. C., Canada:			.....	.....
Asphalt production and shipping facilities	.....	Building	.....	.....
Standard Oil Co. of California, Salt Lake City:				
Refinery, bbl. per day	25,000	Planned	.....	.....
Standard Oil Co. of California, Bakersfield:				
Cat. cracking unit, bbl. per day	10,000	Authorized	Mid '49	.....
Alteration to crude unit, bbl. per day	20,000	Authorized	.....	.....
Standard Oil Co. of California, Salt Lake City:				
Crude unit, bbl. per day	25,000	Authorized	Late '48	.....
Standard Oil Co. (Ind.), Whiting, Ind.:				
Cat. cracking unit, bbl. per day	25,000	Building	1948	The M. W. Kellogg Co.
Expanding crude and coking units, bbl. per day	27,000	Building	1948	The Lummus Co.
Standard Oil Co. (Ind.), Sugar Creek, Mo.:				
Cat. cracking unit, bbl. per day	25,000	Building	1948	The M. W. Kellogg Co.
Polymerization unit, bbl. per day	1,150	Building	.....	.....
Standard Oil Co. (Ind.), Casper, Wyo.:				
Cat. cracking unit, bbl. per day	8,000	Building	1949	The M. W. Kellogg Co.
Standard Oil Co. (Ohio), Lima, Ohio:				
Cat. cracking unit, bbl. per day	16,000	Building	Late '49	Arthur G. McKee & Co.
Gas-recovery unit	.....	Building	Late '48	None
Standard Oil Co. (Ohio), Latonia, Ky.:				
Waste-oil separator	.....	Authorized	Late '48	Contract not let
Stanolind Oil & Gas Co., Hugoton field, Kansas:				
Hydrocarbon synthesis plant, cu. ft. per day	100,000,000	Authorized	Early '50	The M. W. Kellogg Co., Foster Wheeler Corp., Stone & Webster Engineering Corp.
Chemicals recovery and refining, lb. per year	100,000,000	Authorized	Early '50	E. B. Badger & Sons Co.
Stanolind Oil & Gas Co., Brownsville, Tex.:				
Chemicals recovery and refining, lb. per year	100,000,000	Authorized	Mid '49	E. B. Badger & Sons Co.
Sun Oil Co., Marcus Hook, Pa.:				
Furfural unit, bbl. per day	2,000	Building	Early '48	Process Engineers, Inc.
M.E.K. unit, bbl. per day	1,800	Building	Early '48	Process Engineers, Inc.
Compounding plant	.....	Building	.....	.....
Sunray Oil Corp., Allen, Okla.:				
Modernizing vacuum unit	.....	Building	Early '48	.....
Sunray Oil Corp., Duncan, Okla.:				
Expanding refining facilities, bbl. per day	20,000	Building	Early '48	The Refinery Engineering Co., Mason Bros.
Texas Co., The, Westville, N. J.:				
New refinery, bbl. per day	40,000	Building	Mid '49	Foster Wheeler Corp., The M. W. Kellogg Co., Jackson-Moreland
Texas Co., The, West Tulsa:				
Refinery modernization, bbl. per day	30,000	Building	Mid '49	Foster Wheeler Corp., The M. W. Kellogg Co., Universal Oil Products Co.
Texas Co., The, Port Arthur, Tex.:				
Expansion of lube facilities	.....	Building	Early '49	Foster Wheeler Corp.
Alteration of treating facilities	.....	Building	Early '49	Foster Wheeler Corp.

PLANT-CONSTRUCTION PROJECTS (Continued)

Company, location and type of project—	Capacity rating	Status	Comp. schedule	Contractors
Texas Co., The, Lawrenceville, Ill.:				
Refinery expansion, bbl. per day	20,000	Planned	.....	.....
Troy Refining Co., Inc., Troy, Ind.:				
Moving and expanding refinery	.....	Considered	.....	.....
Trinidad Leaseholds (Canada), Ltd., Port Credit, Canada:				
Treating plant	.....	Planned	.....	.....
Union Oil Co. of California, Oleum, Calif.:				
Lube-oil plant, bbl. per day	1,100	Planned	Mid '49	.....
Addition to coker, bbl. per day	19,500	Building	.....	.....
United Refining Co., Warren, Pa.:				
New laboratory	.....	Planned	.....	.....
Boiler capacity increase	.....	Planned	.....	.....
Utah Oil & Refining Co., Salt Lake City.:			.....	.....
Refinery expansion	.....	Authorized	Late '48	.....
Western States Refining Co., North Salt Lake, Utah:				
New refinery, bbl. per day	1,500	Building	.....	.....
Wood River Oil & Refining Co., Wood River, Ill.:				
Perco cat. and reforming, bbl. per day	8,000	Building	Early '48	Koch Engineering Co., Inc.
Enlarge crude unit, bbl. per day	35,000	Building	Late '48	Koch Engineering Co., Inc.
Winnsboro Refining Co., Winnsboro, Tex.:				
New refinery, bbl. per day	2,800	Building	Early '48	Petro Chemical Engineering & Construction Corp.

Refinery-Construction Projects Outside the U. S.

EXTENSIVE plans have been announced for increasing refining capacity in various countries other than the United States. Several of the projects under contract are still not under way because of construction-material shortages. Other projects have reached the authorized stage while some have progressed well beyond "planning" but have not yet been authorized.

The following list of refinery construction projects includes the latest information available directly from the different operating companies throughout the world.

FOREIGN REFINERY CONSTRUCTION

Belgium

Location and company—	Capacity	Status
Raffinerie Belge de Petroles, Antwerp:		
Topping and vacuum units, bbl. per day	2,000	Building
Reforming unit	.....	Building

Bolivia

Yacimientos Petroliferos Fiscales:		
Cochabamba:		
Refinery, bbl. per day	5,000	.....
Sucre:		
Skimming plant, bbl. per day	2,000	.....

Brazil

Refineria de Petroleos do Distrito Federal S.A., Rio de Janeiro:		
Refinery, bbl. per day	10,000	Planned

Burma

Burmah Oil Co., Ltd., Syriam:		
Refinery reconstruction, bbl. per day	20,000	Planned
British Burmah Petroleum Co., Ltd.:		
Seikkyi:		
Refinery reconstruction, bbl. per day	3,500	Planned
Thilawa:		
Refinery reconstruction, bbl. per day	2,500	Planned

Canary Islands (Spain)

Cia. Espanola de Petroleos S.A., Sta. Cruz de Tenerife:		
Capacity increase, bbl. per day	6,000	Planned

East Indies (Sarawak)

Sarawak Oil Fields, Ltd. (Shell), Island of Maura:		
New refinery	.....	Planned

(Sumatra)

De Bataafsche Petroleum Mij. (Shell), Pladjoe:		
Capacity increase, bbl. per day	10,000	Building
Standard-Vacuum Petroleum Mij., Palembang:		
Capacity increase, bbl. per day	25,000	Building

Ecuador

Anglo-Ecuadorian Oil Fields, Ltd., La Libertad:		
Capacity increase, bbl. per day	1,200	Building

France

Location and company—	Capacity	Status
Cie. Francaise de Raffinage, Gonfreville-L'Orcher:		
Crude distillation unit, bbl. per day	20,000	Building
Tannin solutizer unit, bbl. per day	16,000	Building
Raffinerie de Petrole du Nord, Dunkerque:		
Refinery, bbl. per day	26,000	Planned

Iraq

Iraq Petroleum Co., Ltd., Kirkuk field:		
Expand H_2S removal plant, bbl. per day	270,000	Building

Italy

Azienda Nazionale Idrogenazione Combustibili:		
Leghorn:		
Capacity increase, bbl. per day	30,000	Planned
New cat. cracking units (3)	.....	.....
Bari:		
Capacity increase, bbl. per day	5,000	.....

Mexico

Petroleos Mexicanos, Salamanca:		
Refinery, bbl. per day	30,000	Contracted

Netherlands

Caltex Petroleum Mij., Rotterdam:		
Refinery, bbl. per day	20,000	Planned

Palestine

Consolidated Refineries, Ltd., Haifa:		
Capacity increase, bbl. per day	20,000	Planned
Lube-oil plant	.....	Planned

Trieste

"Aquila" S.A. Tecnico-Industriale, Trieste:		
Capacity increase, bbl. per day	2,000	Planned

Trinidad

United British Oilfields of Trinidad, Ltd., Point Fortin:		
Asphalt plant	.....	Building
Addition to asphalt plant	.....	Planned

United Kingdom (England)

Agwi Petroleum Corp., Ltd., Fawley:		
Capacity increase, bbl. per day	105,000	Planned
Shell Refining & Marketing Co., Ltd.:		
Thornton-le-Moors:		
Petrochemical plant	.....	Building
Shell Haven:		
Capacity increase	.....	Planned
Stanlow:		
Capacity increase	.....	Planned

Uruguay

Administracion Nacional de Combustibles, Alcohol y Portland, Montevideo:		
Capacity increase, bbl. per day	6,700	Planned

(Continued on page 232)

NORTH AMERICAN OPERATING REFINERIES

Their Capacities and Locations

Compiled by the Statistical Department of The Oil and Gas Journal

SUMMARY OF ACTIVE PLANTS IN THE UNITED STATES

	No. plants	Barrels daily: Crude-oil capacity	Barrels daily: Cracking capacity
Alabama	2	11,500	.....
Arkansas	6	53,200	21,150
California	55	1,003,050	589,550
Colorado	7	18,300	7,000
Delaware	1	3,500	.....
Georgia	1	5,500	.....
Idaho	1	4,500	3,700
Illinois	16	333,000	233,350
Indiana	8	278,600	167,600
Kansas	18	201,900	139,450
Kentucky	7	60,500	55,800
Louisiana	13	420,100	244,300
Maryland	3	66,000	35,000
Massachusetts	2	49,000	32,000
Michigan	17	112,300	39,800
Minnesota	2	7,500	.....
Mississippi	2	8,000	2,000
Missouri	1	31,900	43,500
Montana	11	44,350	22,800
Nebraska	5	4,400	660
New Jersey	6	316,400	117,300
New Mexico	8	15,750	5,850
New York	6	89,800	39,500
Ohio	12	229,700	234,950
Oklahoma	25	260,200	147,950
Oregon	1	4,200	.....
Pennsylvania	20	451,500	334,460
Rhode Island	3	16,100	1,400
South Carolina	1	6,500	.....
South Dakota	1	100	.....
Tennessee	2	5,500	1,500
Texas	81	1,733,850	1,068,000
Utah	3	23,100	18,900
Washington	1	6,000	2,500
West Virginia	3	13,000	17,650
Wisconsin	1	6,000	.....
Wyoming	18	82,725	64,600
Total	369	5,969,525	3,752,220

EXPLANATION OF ABBREVIATIONS

Cracking capacity is based on daily capacity to produce cracked gasoline. In a few cases companies reported raw-charging capacity.

(Comp.)—Complete plant, gasoline, kerosine, gas oil, fuel oil, lubricating oils, paraffin, wax, and asphalt, usually includes cracking.

(S)—Gasoline, kerosine, distillate, gas oil, and fuel oil.

(L)—Lubricating oils.

(A)—Asphalt.

(C)—Same products as skimming, except plants are equipped with cracking.

(W)—Wax.

ALABAMA

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
Coastal Petroleum Corp., Mobile	8,000	.....	S
Hunt Oil Co., Tuscaloosa	3,500	.....	S-A
Total	11,500	.....	

ARKANSAS

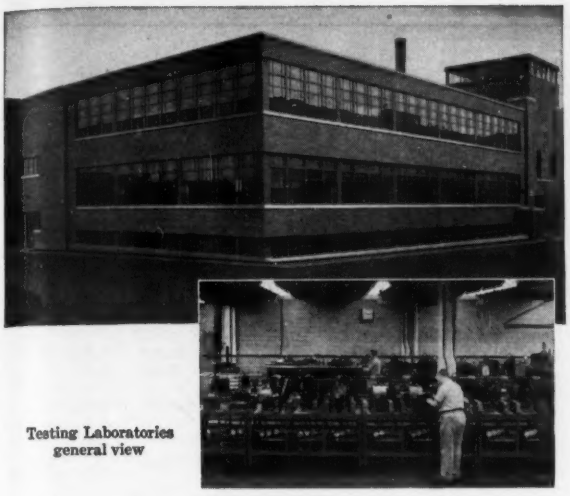
Berry Asphalt Co., Stephens	2,000	.....	S-A
Waterloo	1,200	.....	S-L-A
Cross, Henry H., Co., Smackover	4,000	.....	S-L-A
Lion Oil Co., El Dorado[3]	22,000	7,400	C-L-A
MacMillan Pet. Co., Norphlet	4,000	.....	S-L
Root Pet. Co., El Dorado[1]	20,000	13,750	C
Total	53,200	21,150	

CALIFORNIA

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
Armalene, Inc., Long Beach	1,500	.....	S
Ben Hur Ref. Co., Long Beach	2,500	.....	S
Calstate Ref. Co., Long Beach	.....	1,600	C
Caminol Co., Ltd., Hanford	3,100	600	C
Santa Fe Springs	3,500	1,100	C
Century Oil Co., Long Beach	5,000	.....	S
Douglas Oil Co. of Calif., Santa Maria	3,000	.....	S-A
Clearwater	3,500	.....	S-A
Bakersfield	6,000	3,500	C
Eagle Oil & Ref. Co., Inc., Santa Fe Springs	5,000	1,500	C
Economy Asphalt Co., Oxnard	500	.....	A
Edgington Oil Refinery, Long Beach	2,500	.....	S
Envoy Pet. Co., Long Beach	4,000	.....	S-A
Exeter Ref. Co., Long Beach	10,000	.....	S-A
Five C Refining Co., Santa Maria	3,000	.....	S-A
Fletcher Oil Co., Wilmington	3,500	1,200	S-A
General Pet. Corp., Lebec	23,000	.....	S
Torrance[3]	100,000	76,000	C
Vernon	4,000	.....	S-A
Golden Bear Oil Co., Oildale	2,500	.....	S-L-A
Hancock Oil Co. of Calif., Long Beach	12,500	20,000	C
Harbor Ref. & Trans. Co., Long Beach	3,000	.....	S
Lunday-Thagard Oil Co., South Gate	750	.....	A
MacMillan Pet. Corp., Long Beach	7,500	.....	S
McCallen Ref. Co., Ltd., Huntington Beach	5,000	.....	S
Mohawk Pet. Corp., Bakersfield	7,800	4,500	C
Newhall Ref. Co., Newhall	3,000	.....	S-A
Norwalk Co., Maricopa	8,000	.....	S
Pacific States Oil Co., Wilmington	25,000	.....	S
Palomar Ref. Co., Bakersfield	1,300	.....	S-L-A
Paraffine Companies, The, Inc.	1,500	.....	A
Petrol Corp., Los Angeles	6,000	.....	S-A
Richfield Oil Co., Wilmington	80,000	63,000	Comp
Rotschild Oil Co., Santa Fe Springs	6,000	1,400	C
Seaside Oil Co., Ventura	4,500	.....	S-A
Shell Oil Co., Inc., Martinez	45,000	26,000	Comp.
Wilmington[1]	52,000	52,000	C
Socal Oil & Ref. Co., Huntington Beach	3,000	1,500	C
Soto Refining Co., Los Angeles	3,200	.....	S

SURVEY OF OPERATING REFINERIES

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
Standard Oil Co. of Calif., Bakersfield	15,000	.....	S-A
El Segundo[2]	100,000	71,450	Comp.
Richmond[2]	125,000	88,500	Comp.
Sunland Ref. Corp., Bakersfield	3,000	.....	S
Sunray Oil Corp., Santa Maria	7,000	2,500	C-A
Sunset Oil Co., Torrance	4,000	.....	S
Texas Co., The, Fillmore	5,000	3,600	C
Los Angeles[2]	50,000	32,000	C
Tide Water Associated Oil Co., Avon[1]	60,900	51,400	Comp.
Wilmington	14,000	8,200	C
Triangle Oil & Ref. Co., Venice	2,500	.....	S
Union Oil Co. of Calif., Bakersfield	8,500	.....	S-A
Oleum[4]	64,500	6,000	Comp.
Wilmington[2]	59,000	58,000	C-A
Western Asphalt & Ref. Co., Santa Maria	1,500	.....	S-A
Wilshire Oil Co., Inc., Norwalk	22,000	14,000	C
Total	1,003,050	589,550	
COLORADO			
Bay Pet. Corp., Denver	5,000	2,000	C
Continental Oil Co., Denver	3,500	1,500	C
Empire Petroleum Co., Denver	2,000	.....	S
Gordon Ref. Co., Fort Morgan	200	.....	S
Oriental Ref. Co., Alamosa	1,100	900	C
Denver	5,000	2,000	C
Skelly Oil Co., Denver	1,500	600	C
Total	18,300	7,000	
DELAWARE			
Texas Co., The, Claymont	3,500	.....	A
GEORGIA			
Mexican Pet. Corp. of Ga., Savannah	5,500	.....	S-A
IDAHO			
Wasatch Oil Co., Pocatello	4,500	3,700	C
ILLINOIS			
Advance Ref. Co., Centralia	2,800	.....	S
Calumet Ref. Co., Burnham	1,200	.....	S-L
Cross, Henry H., Co., Colmar	1,000	.....	S
Dupo	1,000	.....	S
Globe Oil & Ref. Co., Lemont	27,000	5,500	C
Great Lakes Ref. Co., Blue Island	10,000	2,200	C
Ohio Oil Co., The, Robinson	15,000	9,000	C-A
Pana Ref. Co., Pana	4,000	1,750	C
Red River Ref. Co., Burnham	1,100	.....	S
Shell Oil Co., Inc., Wood River[1]	100,000	86,000	Comp.
Socony-Vacuum Oil Co., Inc., East St. Louis[2 3]	20,000	24,400	Comp.
Stanolind Oil Co. (Ind.), Wood River[1]	42,500	30,500	Comp.
Texas Co., The, Lawrenceville	27,000	14,000	Comp.
Texas Co., The, Lockport[1]	55,000	50,000	Comp.
Wireback, B. F., Plymouth	400	.....	S
Wood River Oil & Ref. Co., Inc., Hartford[4]	25,000	10,000	C-A
Total	333,000	233,350	
INDIANA			
Cities Service Oil Co. (Del.), East Chicago	30,000	18,000	Comp.
Indiana Farm Bur. Coop. Assn., Inc., Mt. Vernon	4,500	2,500	C
Johnson Oil Supply Co., Gary	2,500	.....	S
Rock Island Ref. Corp., Rock Island	8,000	8,600	C-A
Sinclair Ref. Co., East Chicago[1]	55,000	55,000	Comp.
Socony-Vacuum Oil Co., Inc., East Chicago[2]	31,000	18,500	C
Standard Oil Co. (Ind.), Whiting[1]	145,800	65,000	Comp.
Troy Ref. Corp., Troy	1,800	.....	S
Total	278,600	167,600	
KANSAS			
Bareco Oil Co., Wichita	7,500	3,250	C
Bay Pet. Corp., McPherson	6,000	3,600	C
Chanute Ref. Co., Chanute	.....	1,000	C
Coop. Refinery Assn., Coffeyville[1]	13,000	8,800	C-L-W
Phillipsburg	4,000	2,100	C
Derby Oil Co., Wichita	8,000	4,200	Comp.
El Dorado Ref. Co., El Dorado	8,500	12,250	C
Kanotex Ref. Co., Arkansas City	8,500	5,500	C-A
M.F.A. Oil Co., Chanute	1,800	1,000	C
Nat'l. Coop. Refinery Assn., McPherson[5]	18,000	33,000	C
Phillips Pet. Co., Kansas City	36,000	13,000	C
Shallow Water Ref. Co., Shallow Water	2,500	550	C
Sinclair Ref. Co., Coffeyville	13,000	7,000	Comp.
Kansas City	12,000	7,000	C
Skelly Oil Co., El Dorado	25,000	12,000	C-A
Socony-Vacuum Oil Co., Inc., Augusta[3]	24,000	17,900	C-A
Standard Oil Co. (Ind.), Neodesha	8,500	4,600	C
Vickers Pet. Co., Potwin	5,600	2,700	C
Total	201,900	139,450	
KENTUCKY			
Aetna Oil Co., Louisville	8,000	4,600	C
Ashland Oil & Ref. Co., Cattlettsburg[2]	25,000	17,000	Comp.
Atomic Prod. & Ref. Co., Albany	1,500	.....	S
Louisville Ref. Co., Louisville	6,500	7,200	C
Somerset Refinery, The, Somerset	1,500	.....	S
Standard Oil Co. (Ohio), Covington	16,000	27,000	C-A
Stoll Oil Ref. Co., Louisville	2,000	.....	S-L-W
Total	60,500	55,800	
LOUISIANA			
Atlas Oil & Ref. Co., Shreveport	12,000	6,000	S-C
Bayou State Oil Corp., Hosston	800	.....	S-L-A
Calumet Ref. Co., Princeton	700	.....	S
Chalmette Pet. Corp., Chalmette	10,000	6,500	C
Cities Service Ref. Corp., Lake Charles[1]	110,000	95,000	C
Clark's Ref. Div. of Petco Corp., Marrero	5,000	1,800	C
Continental Oil Co., Lake Charles	10,000	5,000	C
Evangeline Ref. Co., Jennings	1,000	.....	S-L
Pan American Ref. Corp., Destrehan	7,500	.....	S-A
Shell Oil Co., Inc., Norco	38,000	21,300	C-A
Southern States Ref., Inc., Eola (Bunkie)	800	.....	S
Esso Standard Oil Co., Baton Rouge	180,000	105,500	Comp
Stanolind Oil & Gas Co., Vivian (Superior)	5,200	3,200	C
Total	420,100	244,300	
MARYLAND			
American Bitumuls, Baltimore	3,000	.....	S-A
Pan American Ref. Corp., Baltimore	8,000	.....	S-A
Esso Standard Oil Co., Baltimore[1]	55,000	31,800	C-L-A
Total	66,000	35,000	
MASSACHUSETTS			
Cities Service Oil Co. (Pa.), East Braintree	15,000	.....	S-A
Esso Standard Oil Co., Everett	34,000	32,000	C-A
Total	49,000	32,000	
MICHIGAN			
Aurora Gasoline Co., Detroit[1]	12,000	4,000	C-A
Elsie	4,000	.....	S
Bay Ref. Corp., Bay City	10,500	.....	S
Crystal Ref. Co. of Carson City, Inc., Carson City	6,200	.....	S
Lakeside Ref. Co., Kalamazoo	2,000	.....	S
Leonard Refineries, Inc., Alma[2]	8,000	7,800	S-C-A
Louis Ross Ref. Co., Saginaw	3,500	1,500	C
Marvel Ref. Co., Grand Rapids	2,000	.....	S
Mid-West Refineries, Inc., Alma	4,000	1,800	C
Naph-Sol Ref. Co., Muskegon	5,100	2,000	C
Old Dutch Ref. Co., Muskegon	4,500	2,000	C
Osceola Ref. Co., Reed City	1,500	.....	S
Petroleum Specialties, Inc., Flat Rock	3,500	.....	S
Producers Ref., Inc., West Branch	3,500	.....	S-A
Pure Oil Co., Midland	5,500	.....	C
Roosevelt Oil Co., Mount Pleasant	8,500	4,000	S
Socony-Vacuum Oil Co., Inc., Trenton[3]	28,000	16,700	C
Total	112,300	39,800	
MINNESOTA			
Northwestern Ref. Co., St. Paul Park	5,000	.....	S-A
New Brighton	2,500	.....	S
Total	7,500	.....	
MISSISSIPPI			
Paluxy Asphalt Co. (Crupp), Yazoo City	3,500	2,000	C-A
Southland Oils, Inc., Sandersville	4,500	.....	S-A
Total	8,000	2,000	



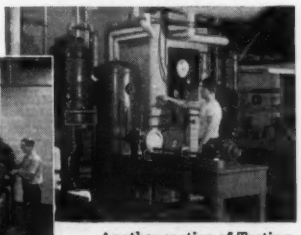
Testing Laboratories general view

Research

Starting in 1887 with the fundamental question—"what makes packing pack?"—Garlock has extended its research from year to year until the newly constructed building shown above is now required to house Garlock's research activities. Garlock products are developed, improved and refined in these completely modern chemical, physical and rubber-compounding laboratories; thoroughly tested in the fully equipped test department and processed in the pilot plant before ever reaching the production department. This *Quality Control* is your assurance of uniformly high quality in every product sold under the Garlock name.

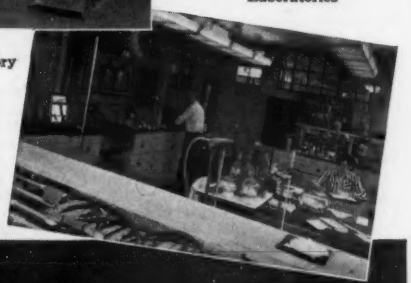
THE GARLOCK PACKING CO., PALMYRA, N.Y.
Tulsa, Okla. Houston, Tex. Los Angeles, Calif.

Compounding Laboratory



Another section of Testing Laboratories

Chemical Laboratory



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There's no question about the extra reliability that specialized Red Seal engines provide. But when, after months or even years of dependable service, a Red Seal engine needs a checkup, it's good to know there's authorized service available — that the Continental Motors service network is as broad as the nation itself.

Red Seal parts are low in cost because they're manufactured in volume. Regardless of the specific job for which the engine is intended, many of the parts are built by aircraft engine methods, to aircraft engine tolerances and precision standards. Wherever you are, there's a Continental dealer nearby, to back you up with complete stocks of parts and with factory-trained service. It's another reason why Red Seal engines are first choice for so many oil field uses.

Continental Motors Corporation

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CONTINENTAL

Red Seal

ENGINES

SURVEY OF OPERATING REFINERIES

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
MISSOURI			
Standard Oil Co. (Ind.), Sugar Creek[1]	31,900	43,500	C-W-A
MONTANA			
Big West Oil Co., Kevin	1,500	1,000	C-A
Carter Oil Co., Billings	11,000	3,300	C-A
Cut Bank	4,000	1,500	C-A
Farmers Union Control Exchange, Inc., Laurel	8,800	5,200	C-A
Hole Brothers Refinery, Cut Bank	350	.....	S
Home Oil & Ref. Co., Great Falls	2,200	3,600	C-A
Texas Co., The, Sunburst	7,500	6,000	C
Treasure State Ref. Co., Shelby	500	.....	S-A
Tri-Petroleum Corp., Hardin	3,000	.....	S
Union Oil Co. of Calif., Cut Bank	4,500	2,200	C
Unity Pet. Corp., Kalispell	1,000	.....	S
Total	44,350	22,800	
NEBRASKA			
Coop. Refinery Assn., Scottsbluff	1,600	660	C
Oil Marketing & Ref., Inc., Salem	800	.....	S
Petroleum Utilities, Inc., Chadron	700	.....	S
Porter Oil Co., Sidney	300	.....	S
Searle Pet. Co., Salem	1,000	.....	S
Total	4,400	660	
NEW JERSEY			
California Ref. Co., Perth Amboy	15,000	4,000	C-A
Cities Service Oil Co. (Pa.), Linden	12,000	.....	A
Cities Service Oil Co. (Pa.), Petty's Island	10,000	.....	S-A
Socony-Vacuum Oil Co., Inc., Paulsboro[2,3]	36,400	24,800	Comp.
Esso Standard Oil Co., Linden[1]	173,000	116,000	Comp.
Tide Water Associated Oil Co., Bayonne[2]	70,000	32,500	Comp.
Total	316,400	177,300	
NEW MEXICO			
Aerex Co., Bloomfield	100	.....	S
Continental Oil Co., Artesia	2,800	1,250	C
Farmington	750	.....	S
Malco Refineries, Inc., Roswell	2,500	1,000	C
McNutt Oil & Ref. Co., Brickland	3,000	600	C
New Mexico Asphalt & Ref. Co., Artesia	4,000	2,000	C
Petroleum Products Ref. & Prod., Prewitt	2,000	1,000	S
Warren Pet. Corp., Monument	600	.....	S
Total	15,750	5,850	
NEW YORK			
Frontier Oil Ref. Co., Tonawanda	10,000	2,500	C
Gulf Oil Corp., Staten Island	20,000	.....	S
Sinclair Ref. Co., Wellsville	11,000	6,000	Comp.
Socony-Vacuum Oil Co., Inc., Brooklyn[3]	19,800	17,000	Comp.
Buffalo[3]	22,300	14,000	Comp.
Olean	6,700	.....	S
Total	89,800	39,500	
OHIO			
Canton Ref. Div. of Central Pipe Line Co., Canton	8,500	2,000	C
Dewese, Henry A.	500	.....	S
Gulf Ref. Co., Cleves	26,600	14,000	C
Toledo	23,000	10,000	C
National Ref. Co., Findlay	9,200	4,450	Comp.
Pure Oil Co., Newark[1]	15,500	41,200	C
Toledo	29,400	67,800	C
Standard Oil Co. (Ohio), Cleveland[3]	42,000	57,000	Comp.
Lima	18,000	14,500	C
Toledo	20,000	24,000	Comp.
Sun Oil Co., Toledo[3]	35,000	31,000	C
Western Reserve Ref. Co., Niles	2,000	.....	S
Total	229,700	234,950	
OKLAHOMA			
Allied Materials Corp., Stroud	1,500	.....	S-A
Anderson-Prichard Ref. Corp., Cyril	10,000	5,000	C-A
Bareco Oil Co., Barnsdall	.....	.....	W
Bell Oil & Gas Co., Granfield	5,000	6,550	C
Ben Franklin Ref. Co., Ardmore	5,000	6,550	C
Champlin Ref. Co., Enid	18,000	9,000	C-L-W
Cities Service Oil Co. (Del.), Ponca City	11,000	4,500	C-L-W
Continental Oil Co., Ponca City[2]	33,000	33,500	Comp.
Deep Rock Oil Corp., Cushing	12,000	5,000	Comp.
Denver Prod. & Ref. Co., Edmond	2,000	.....	S
Fen-Ter Ref. Co., Wynnewood	6,000	1,500	C-A
Johnson Oil Ref. Co., Cleveland	5,500	2,750	S
Mercury Oil Ref. Co., Oklahoma City	2,000	1,200	C
Mid-Continent Pet. Corp., West Tulsa	45,000	17,000	Comp.
Midland Coop. Wholesale, Cushing	5,000	1,600	C
Monarch Refineries, Inc., Oklahoma City	700	.....	S-A
Peppers Ref. Co., Oklahoma City	1,500	.....	S
Phillips Pet. Co., Okmulgee	11,000	1,600	C-L
Rock Island Ref. Co., Duncan	8,500	3,000	C-A
Sinclair Ref. Co., Sand Springs	7,000	.....	S-L-W
Sunray Oil Corp., Allen	12,500	9,000	C
(Beckett) Duncan[1]	20,000	16,000	C-A
Texas Co., The, West Tulsa	21,000	13,000	Comp.
Tide Water Associated Oil Co., Drumright	12,000	5,000	C
Wilcox Oil Co., Bristow	5,000	2,200	C
Total	260,200	147,950	
OREGON			
California Asphalt Co., Portland	4,200	.....	S-A
PENNSYLVANIA			
Atlantic Ref. Co., Philadelphia[1]	112,000	95,500	Comp.
Cities Service Oil Co. (Pa.), Titusville	3,000	.....	S-L-W
Continental Ref. Co., Oil City	1,000	400	Comp.
Daugherty Ref. Div. (L. Sonneborn Sons), Petrolia	4,000	.....	S-L-W
Franklin Ref. Div. of L. Sonneborn Sons, Inc., Franklin	2,000	.....	S-L
Freedom-Valvoline Oil Co., Freedom	4,000	1,000	C-L-W
Gulf Oil Corp., Neville Island	14,500	6,000	C
Philadelphia[1]	74,700	41,000	C-L
Kendall Ref. Co., Bradford	5,000	2,200	Comp.
Pennsylvania Ref. Co., Karns City	2,000	.....	S-L-W
Titusville	1,500	.....	S-L
Pennzoil Co., Rouseville	8,500	7,600	Comp.
Quaker State Oil Ref. Corp., Emlenton	2,000	1,350	Comp.
Farmers Valley	4,000	1,350	Comp.
Oil City	2,800	1,600	Comp.
Sinclair Ref. Co., Marcus Hook[1]	65,000	65,000	C
Sun Oil Co., Marcus Hook[3]	135,000	108,500	Comp.
United Ref. Co., Warren	5,500	2,000	Comp.
Waverly Oil Works Co., Pittsburgh	2,500	.....	S-L-W
Wolf's Head Oil Ref. Co., Inc., Reno	2,500	960	Comp.
Total	451,500	334,460	
RHODE ISLAND			
American Bitumuls, East Providence	1,400	.....	S-A
Socony-Vacuum Oil Co., Inc., East Providence	11,200	1,400	C-A
Texas Co., The, Providence	3,500	.....	A
Total	16,100	1,400	
SOUTH CAROLINA			
Esso Standard Oil Co., Charleston	6,500	.....	A
SOUTH DAKOTA			
Rex Oil Ref. Co., Rapid City	100	.....	S
TENNESSEE			
Delta Ref. Co., Memphis	4,500	1,500	C-A
Southern Oil Service, Nashville	1,000	.....	S
Total	5,500	1,500	
TEXAS			
Alamo Ref. Co., Sweeny	35,000	11,000	C
American Mineral Spirits Co., Corpus Christi	13,000	.....	S
Atlantic Ref. Co., Port Arthur[1]	33,000	40,000	C
Baird Ref. Co., Baird	2,500	2,750	C
Bennett Oil & Ref. Co. of Texas, Refugio	1,500	.....	S
Bryson P. L. & Ref. Co., Bryson	1,500	250	C
Coastal Refineries, Inc., Port Isabel	7,000	2,500	C
Col-Tex Ref. Co., Colorado City	12,000	4,000	C-A
Consumers Coop. Refinery Assn., Levelland	7,000	2,600	C
Continental Oil Co., Wichita Falls	6,300	3,300	C
Cosden Pet. Corp., Big Spring	17,000	12,000	C
Crown Central Pet. Corp., Houston[2]	26,000	21,000	C-L
Danaho Ref. Co., Pettus	4,000	600	C
Eastern States Pet. Co., Houston	35,000	27,000	C-A
Eddy Ref. Co., Houston	2,200	.....	S
Gladewater Ref. Co., Gladewater	2,700	1,800	C
Graytex Ref. Co., Graham	300	.....	S-L
Great Southern Corp., Corpus Christi	.....	4,000	C
Gulf Oil Corp., Fort Worth	9,500	4,000	C
Port Arthur[2,3]	206,000	98,000	Comp.
Sweetwater	10,000	4,000	C

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
Hamman Oil & Ref. Co., Bay City	2,100	.....	S-W
Humble Oil & Ref. Co., Baytown[1]	200,000	140,000	Comp.
San Antonio	7,000	.....	S
Hutex Oil & Ref. Co., Hardin	750	.....	S
Independent Ref. Co., Arp	4,500	5,000	C
Inland Ref. Co., Palestine (Tucker Switch)	2,000	.....	S
Lacy, R., Inc., Big Sandy	4,000	1,500	C
La Salle Pet. Corp., Burkburnett	1,700	.....	S
Magnolia Pet. Co., Beaumont[2 3]	135,000	99,000	Comp.
Fort Worth	12,000	9,300	C
Maritime Oil Co., Houston	5,000	.....	S
Master Pet. Co., Dallas	2,000	.....	S-L-A
McBride Ref. Co., La Blanca	3,000	.....	S-L-A
McMurrey Ref. Co., Tyler	9,000	4,500	C
Mex-Tex Oil Co.	200	.....	S
Onyx Ref. Corp., Hawley	3,000	800	C
Owen Ref. Co., Hawley	1,100	.....	S
Pan American Ref. Corp., Texas City[1]	104,000	23,000	C
Panhandle Ref. Co., Leuders	1,500	700	C
Wichita Falls	4,000	1,700	C
Patton Oil Co., Rotan	1,000	.....	S
Payward Ref. Co., Shamrock	1,000	.....	S
Peerless Tank Cleaning Co., Kilgore	1,000	.....	S
Petrol Terminal Corp., Texas City[3]	50,000	16,500	C
Petrolite Corp., Ltd., Kilgore	100	.....	S
Phillips Pet. Co., Borger[4]	50,000	23,000	C
Pioneer Oil & Ref. Co., Somerset	2,000	.....	S-L-A
Pontiac Ref. Corp., Corpus Christi	20,000	.....	S
Premier Oil Ref. Co., Longview	4,000	4,800	C
Fort Worth	7,000	5,000	C-L-W
Prichard Ref. Co., San Antonio	1,500	.....	S
Pure Oil Co., Nederland[2]	60,000	108,000	C
Rado Ref. Co., McAllen	3,000	.....	S
Republic Oil Ref. Co., Texas City	35,000	8,500	C
Shamrock Oil & Gas Corp., Sunray	6,300	5,000	C
Shell Oil Co., Inc., Houston[1]	100,000	71,000	C
Sid Richardson Ref. Co., Texas City	18,500	2,000	C
Sinclair Ref. Co., Corpus Christi	21,000	20,000	C
Fort Worth	6,500	4,500	C
Houston[2 3]	73,000	62,000	Comp.
Skelly Oil Co., Longview	6,000	3,000	C
Southwestern Oil & Ref. Co., Corpus Christi	18,000	.....	S
Standard Oil Co. of Texas, El Paso	18,000	7,500	C
Stone Oil Co., Texas City	7,500	.....	S
Talco Asphalt & Ref. Div., American Liberty Oil Co., Mount Pleasant	12,000	3,500	C-A
Taylor Ref. Co., Corpus Christi	22,500	3,800	C
Texas Co., The, Amarillo	8,000	4,000	C
El Paso	5,000	3,000	C
Houston	27,500	.....	S
Port Arthur[1 2]	135,000	170,000	Comp.
Port Neches	40,000	.....	S-A
San Antonio	7,000	6,000	C
West Dallas	15,000	9,000	C
Texoil Service Co., Kilgore	1,000	.....	S-W
Three Rivers Refinery, Three Rivers	1,500	.....	L-A
Tydal Ref. Co., Gainesville	1,500	.....	S
United Gas P. L. Co., Beeville	600	.....	S
Waggoner, W. T., Estate, Electra	7,500	3,000	C
Wickett Ref. Co., Wickett	3,000	.....	S
Winnsboro Ref. Co., Winnsboro	3,000	.....	S
Total	1,733,850	1,068,000	
UTAH			
Uinta Oil Ref. Co., Jensen	700	.....	S
Utah Oil Ref. Co., Salt Lake City	20,000	17,200	Comp.
Wasatch Oil Ref. Co., Woods Cross	2,400	1,700	C-A
Total	23,100	18,900	
WASHINGTON			
Inland Empire Refineries, Inc., Hillyard	6,000	2,500	C-A
WEST VIRGINIA			
Elk Ref. Co., Falling Rock	5,000	2,000	Comp.
Pure Oil Co., Cabin Creek	5,500	14,300	C-L-W
Quaker State Oil Ref. Corp., St. Marys	2,500	1,350	Comp.
Total	13,000	17,650	
WISCONSIN			
Wisconsin Oil Ref. Co., Inc., Sheboygan	6,000	.....	S
WYOMING			
Carter Oil Co., Lovell	2,500	.....	S
Newcastle	1,900	2,900	C
Continental Oil Co., Glenrock	3,400	1,800	C
Crook County Refinery, Sundance	125	.....	S
Empire State Oil Co., Thermopolis	3,000	.....	S
Frontier Ref. Co., Cheyenne[1]	8,800	4,950	C-A
Gray Refinery, Inc., Newcastle	1,500	.....	S
Husky Ref. Co., Cody	5,000	.....	S-A
Ohio Oil Co., Lovell	6,000	.....	S-A
Pilot Oil Co., Morton	500	200	C
Resolute Oil Corp., Badger Basin	1,000	.....	S
Sinclair Ref. Co., Sinclair[1]	14,000	17,000	C-A
Socony-Vacuum Oil Co., Inc., Casper	4,000	13,000	C-A
Standard Oil Co. (Ind.), Greybull	5,500	1,900	C-A
Casper[1]	13,000	14,350	C-L-W
Texas Co., The, Calpet	400	.....	S
Casper[1]	12,000	9,000	C
Z & W Service & Refinery, Torrington	100	.....	S
Total	82,225	65,100	

OPERATING REFINERIES IN CANADA

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
ALBERTA			
British American Oil Co., Ltd., Calgary	5,500	2,500	C-A
Gold Standards Oils, Ltd., Wainwright	250	.....	S
Imperial Oil, Ltd., Calgary	10,000	5,000	C-A
Imperial Oil, Ltd., Edmonton	6,000	3,000	C-A
Total	21,750	10,500	
BRITISH COLUMBIA			
Imperial Oil Ltd., Ioco	12,000	3,000	Comp.
Shell Oil Co. of B. C., Shelburn	5,000	2,600	C-A
Standard Oil Co. of B. C., Ltd., Vancouver	5,000	.....	S-A
Total	22,000	5,600	
MANITOBA			
Anglo-Canadian Oils, Ltd., Brandon	2,300	1,000	C
North Star Oil, Ltd., St. Boniface	2,000	3,000	C
Radio Oil Ref., Ltd., Winnipeg	1,000	.....	S
Total	5,300	4,000	
NEW BRUNSWICK			
New Brunswick Gas & Oilfields, Ltd., Weldon	300	.....	S
NOVA SCOTIA			
Imperial Oil, Ltd., Dartmouth	24,000	8,440	C-A
ONTARIO			
British-American Oil Co., Ltd., Clarkson	10,000	4,400	Comp.
Toronto	5,000	.....	C
Canadian Oil Companies, Ltd., Petrolia	4,000	4,000	C
Imperial Oil Ltd., Sarnia	55,000	27,000	Comp.
McColl-Frontenac Oil Co., Ltd., Toronto	12,000	7,000	C
Trinidad Leaseholds, Ltd., Port Credit	4,500	2,600	C
Total	90,500	45,000	
QUEBEC			
British-American Oil Co., Ltd., Montreal	15,000	7,500	C-A
Imperial Oil, Ltd., Montreal	34,600	8,000	C-A
McColl-Frontenac Oil Co., Ltd., Montreal	24,000	14,400	C
Shell Oil Co. of Canada, Ltd., Montreal East	10,500	7,000	C
Total	84,100	36,900	
SASKATCHEWAN			
British-American Oil Co., Ltd., Moose Jaw	5,000	2,000	C-A
Hi-Way Refineries, Ltd., Moose Jaw	300	.....	S
Hi-Way Refineries, Ltd., Rosetown	300	.....	S
Hi-Way Refineries, Ltd., Saskatoon	350	.....	S
Husky Ref. Co., Lloydminster	2,500	.....	S-A
Imperial Oil, Ltd., Regina	10,000	8,000	C-A
Northern Pet. Corp., Ltd., Kamsack	500	.....	S-L
Saskatchewan Federated Cooperatives, Ltd., Regina	2,000	1,000	C
Total	20,950	11,000	

REFINERIES IN MEXICO

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
Petroleos Mexicanos, Arbol Grande, Tamp.	22,000	.....	L-W-A
Petroleos Mexicanos, Atzcapotzalco, D. F.	50,000	13,000	C

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
Petroleos Mexicanos, Bella Vista	.....	1,100	C
Petroleos Mexicanos, Ciudad Madero, Tamp.	60,000	4,900	Comp.
Petroleos Mexicanos, Mata Redonda	13,000	8,000	C
Petroleos Mexicanos, Minatitlan	26,000	.....	S-L
Petroleos Mexicanos, Poza Rica, Ver.	4,000	.....	S
Petroleos Mexicanos, Villa Cuauhtemoc, Ver.	13,400	9,300	C
Total	188,400	36,300	

SHUTDOWN PLANTS IN THE U.S.

ARKANSAS			
Stephens Ref. Co., Inc., Stephens	2,500	.....	S
CALIFORNIA			
Harbor Ref. Co., Wilmington	3,000	.....	S
Olympic Ref. Co., Long Beach	6,500	.....	S
Operators Oil & Ref. Co., Long Beach	5,000	.....	S
Rice Ranch Oil Co., Santa Maria	1,000	.....	S
Richfield Oil Corp., Bell	10,000	4,500	S-C
Shell Oil Co., Inc., Coalinga	6,700	.....	S
Standard Oil Co. of Cal., Kettleman Hills	1,000	.....	S
Total	33,200	4,500	

Company and plant location—	Crude oil cap. bbl.	Cracking cap. bbl.	Type of refinery
COLORADO			
Raven Oil & Ref. Co., Rangely	115	.....	S
IDAHO			
Gem State Refining Co., Twin Falls	3,000	.....	S
ILLINOIS			
Allied Oil Corp., St. Elmo	5,000	1,500	C
Sol-Tex Ref. Co., Fairfield	2,500	.....	S
Total	7,500	1,500	
KENTUCKY			
Ashland Oil & Ref. Co., Pryse	5,000	2,000	S-C
LOUISIANA			
Arkansas Fuel Oil Co., Bossier City	28,000	14,000	C
Coast Oil Co., Cotton Valley	1,500	.....	S
Meraux Pet. Storage Co., Meraux	3,000	.....	S
Total	32,500	14,000	
MONTANA			
Big Lake Oil Co., Lake Basin	100	.....	S
Gallatin Farmers Co., Belgrade	240	.....	S
Hart Refineries, Missoula	500	.....	S
Hunt, D. Eugene, Winnett	300	.....	S
North American Oil & Ref. Co., Chinook	300	.....	S
North Star Ref. Co., Shelby*	2,500	.....	S
Patterson, H. F., Ref. Co., Sweet Grass	800	.....	S
Unity Pet. Corp., Kalispell	1,200	250	S-C
Total	5,940	250	
*Moving to Laurel, Mont.			
NEBRASKA			
Mid-States Ref. Co., Falls City	3,000	.....	S
NEW YORK			
Allegany Refineries, Inc., Bolivar	1,500	.....	S
SOUTH DAKOTA			
Sturgis Ref. Co., Sturgis	100	.....	S
TEXAS			
Danciger Oil & Ref. Co., Longview	7,500	4,000	C
Minerva Ref. Co., Corsicana	1,000	.....	S
Muenster Ref. Co., Muenster	750	.....	S
Phillips Pet. Co., Pampa	7,000	3,500	S
Scurlock Oil Co., Post	750	.....	S
Uvalde Rock Asphalt Co., Uvalde	500	.....	S-A
Total	17,500	7,500	
WYOMING			
Silver Tip Refinery, Yoder	100	.....	S

SHUTDOWN PLANTS IN CANADA

Abasand Oils, Ltd., Fort McMurray, Alta.	800	600	S-C-A
Diana Oil & Ref. Co., Lloydminster, Sask.	250	.....	S
Home Oil Distributors, N. Vancouver, B. C.	2,000	.....	S-L
Total	3,050	600	

Refinery-Construction Outside U. S.

(Continued from page 226)

Venezuela

Location and company—	Capacity	Status
Creole Petroleum Co., Amuay Bay:		
Refinery, bbl. per day	60,000	Building
Mene Grande Oil Co., Puerto La Cruz:		
Refinery, bbl. per day	20,000	Planned
Royal Dutch-Shell (interests), Punta Cardon:		
Refinery, bbl. per day	60,000	Building
Sinclair Oil Corp., Puerto La Cruz:		
Refinery, bbl. per day	35,000	Planned

NPC Reports 55 Projects in Nations Outside United States

THE National Petroleum Committee on Analyzation of the Report of Sixteen Nations in connection with the European Recovery Program reports some 55 refinery construction projects for the different countries exclusive of the United States. These projects include new refineries, modernization and extensions to existing plants, and rehabilitation of war-damaged installations. The projects reported by the committee are given in the following table:

PUBLICLY ANNOUNCED PLANNED REFINERY CONSTRUCTION*

Country—	Number of plants	Capacity (bbl./day)
Western Hemisphere:		
Argentina	2	45,000
Bolivia	2	5,000
Brazil	2	12,500
Brazil	1	1,500
Canada	2	12,700
Canada	1	15,000
Chile	1	10,000
Colombia	1	5,000
Ecuador	1	1,200
Mexico	1	30,000
Uruguay	1	6,300
Venezuela	5	180,000
Total Western Hemisphere		324,200
Marshall countries:		
Belgium	1	3,000
France	..	130,000
Germany	..	35,000
Great Britain	7	340,000
Italy	1	4,200
Italy	3	39,000
Netherlands	1	20,000
Netherlands	1	45,000
Portugal	1	5,000
Sweden	3	29,000
Sweden	1	1,000
Total Marshall countries		651,200
Eastern Hemisphere excluding Marshall countries:		
Australia	2	4,000
British Borneo	1	20,000
Burma	1	15,000
Canary Islands	1	2,500
Egypt	1	10,000
Formosa	1	11,000
Java-Sumatra-Dutch Borneo	..	100,000
Kuwait	..	20,000
Iraq	1	12,000
Palestine	1	60,000
Spain	1	10,000
Syria	1	20,000
Trieste	1	4,000
Total Eastern Hemisphere excluding Marshall countries		288,500
Total Eastern Hemisphere		939,700

*National Petroleum Council report.

Chemical Treatment of Naphthenic-Base Crude

(Continued from page 169)

plained that the tests as shown are on the heaviest stream drawn (which runs 150/210) after this stream is cut back with 100-viscosity distillate so that it can be readily treated. All of the other four streams are low enough in viscosity so that they can be treated as withdrawn from the distillation unit, but the one heavy side stream which is drawn just above the 10 per cent residuum must be diluted prior to treating. The diluent is removed by fired shell still and steam distillation prior to final percolation on this cut. It should also be pointed out that this heavy 150/210 viscosity distillate as taken from the unit has some market of its own as a lubricant, but the greater portion of it is treated in dilution for production of 100/210 pale oil.

The above discussion briefly covers the crude-distillation processing of the naphthenic crude for the preparation of the five lube-distillate cuts which, from this point, are ready for chemical treatment. By reference to Fig. 1, the various treating steps can be followed. The technique of treating is essentially the same for each grade of distillate, with the main variations being the amounts of chemicals used, length of settling time, and so forth. Tables 1 and 2 show these variations in chemical dosages.

In so far as treatment of these distillates is concerned it is a batch sulfuric acid operation carried out in 1,500-bbl. agitators followed by neutralization with soda ash and water washing in conventional wash tanks. Percolation through fuller's earth is the final finishing step.

The oil is charged into a 1,500-bbl., cone-bottom, lead-lined agitator and the required amount of 98 per cent restored sulfuric acid is drawn from acid storage into a blowcase. A very small or "cutter" dump of acid is usually applied before the main acid application to dry the oil. By pressuring the blowcase with air, the acid is charged into the agitator and at the same time the oil is agitated with air in order to contact with the acid and oil thoroughly. This agitation continues for about 30 minutes, and at this time from 1 to 3 per cent of water based on agitator charge is added to the acid oil mixture in order to "gather" the sludge. Agitation is continued, but at a reduced rate as the sludge separates. By the appearance of the mixture the treater can determine when the sludge has gathered sufficiently to settle and at that time the air agitation is discontinued and the sludge is allowed to settle in the cone. The required settling time to get a clean break varies from 2 to 6 hours depending on the viscosity of the oil treated. The sludge is withdrawn from cone several times during this period to lead-lined kettles, where it is further processed for recovery of acid and boiler fuel.

The clean acid oil is then transferred from the agitator to a wash tank for neutralization and washing. Soda ash solution (10° Be.) is added to the oil stream through orifice mixers as it is being transferred to insure good contact. The soda-ash dosages are indicated in Table 1. The neutralized oil is then heated by closed steam coils in the wash tank to a temperature varying from 170° to 210° F. for settling of the spent soda solution and soaps. This is drawn off and a hot water "spray" wash is put on the oil through overhead spray lines. This wash is settled and a hot water "blow" wash is put on the batch. This merely consists of air rolling slowly the oil with hot water and after it is thus washed thoroughly it is settled, the water withdrawn, and the oil is air blown bright. The oil is then pumped to storage ahead of the percolation filters after which operation they are ready for market.

These finished lubricants find wide application in the industrial and transportation fields both as finished above and in compounded lubricants.

Three methods are widely used to prevent corrosion — protective coatings, special alloys and chemical inhibitors. Each has special merit under certain conditions; but, when water, quiescent or recirculating, remains in contact with ordinary metals, a chemical inhibitor is generally indicated.

Mutual chromates are used extensively as corrosion inhibitors. In most instances surprisingly small amounts are required to prolong indefinitely the life of the exposed metal. These applications include: recirculating spray systems for air washing and conditioning, cooling systems for internal combustion engines, refinery condensers and heat exchangers, oil well drilling muds, slushing compounds and water-soluble cutting oils, gasoline pipe lines, refrigerating brines and sealed-in absorbents for unit refrigerators.

If these uses suggest a possible application for chromates in your operations, our Research Department will be glad to collaborate with you.

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Processing West Texas Crude

(Continued from page 171)

the secondary column. Use of ammonia frequently has been considered but thus far rejected in favor of finding and installing the proper metal to resist corrosion. Ammonia is an adequate solution of a temporary problem, but will in the long run prove more expensive than corrosion-resistant metals to a refinery limited to sour crude all the time.

Very little corrosion trouble is experienced with carbon steel in other parts of the topping plant. The critical points are in the heaters, condensers, wet-condensate lines, and valves and pump impellers on wet condensate. Admiralty and cast iron resist wet-condensate corrosion; lime in the heater saves tubes. Distillate stocks and the residue are handled with no trouble in steel equipment.

Treating Straightrun Gasoline

Clay treatment of the straightrun gasoline was essential during wartime because without it the refinery would have been unable to make 91-octane aviation gasoline. Its effectiveness for increasing lead susceptibility of the straightrun gasoline can best be shown by the typical "before" and "after" tabulation shown in Table 2.

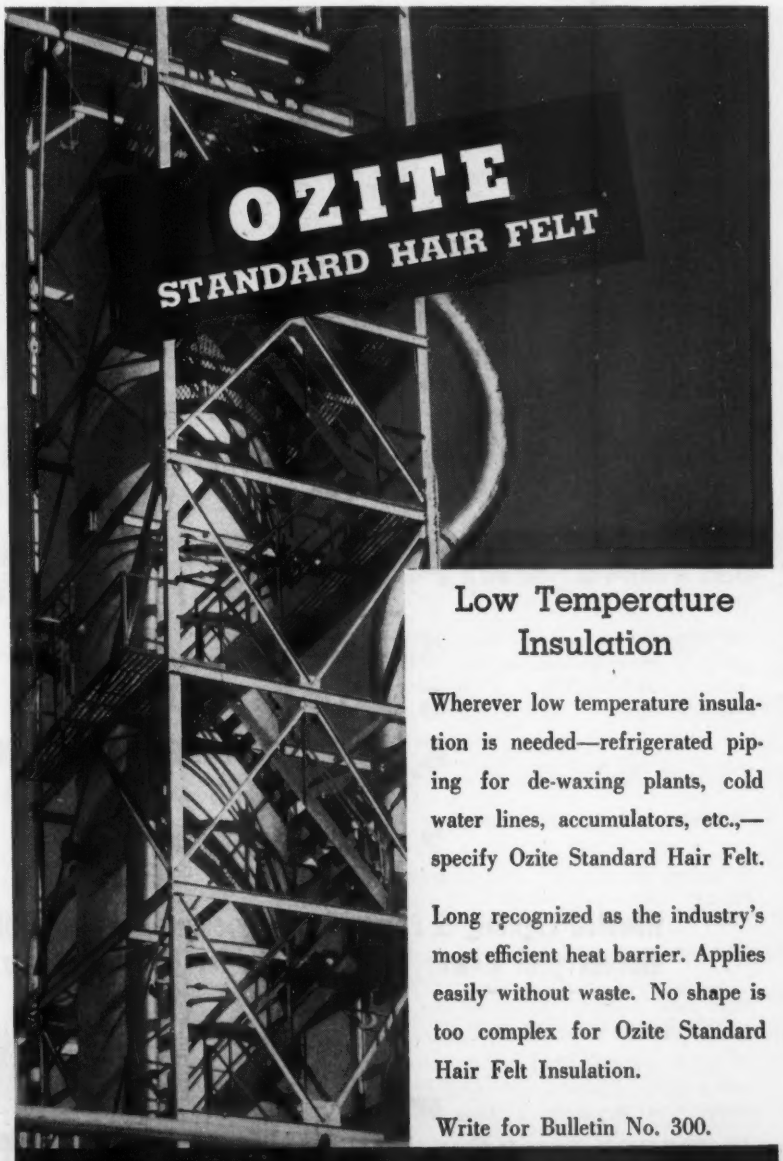
The clay treating process practiced at the Cosden refinery consists in passing gasoline vapors at 700° F. and 35 psi. downward through a bed of 30-60 mesh clay. As the activity of the clay decreases the temperature is raised to 800° F. Since regeneration of the clay is not practiced, selection of the type of clay is based on the economy of clay life to the point where mercaptan content of the effluent gasoline reaches a given value. Each of Cosden's two clay towers (used alternately) is 12 ft. in diameter and is charged with 9 tons of clay to give a depth of 3 ft. Normal gasoline charge rate is 3,500 bbl. per day.

To reduce corrosion in the clay unit, the feed stock is treated in a Girbotol unit where hydrogen sulfide is reduced from 240 to 10 grains per gallon. This treatment also eliminates condensation difficulties in the rerun tower which follows the clay treater. Hydrogen sulfide formed in the clay bed from mercaptans is removed after rerunning by stabilizing the rerun overhead. The stabilizer's bottoms are then given a light caustic wash to guard against residual traces of H_2S and then are doctor treated. When the clay is fresh, doctor treatment is not necessary, but as the clay becomes spent, the gasoline gets doctor sour.

Because of corrosion experienced with even small quantities of H_2S at high temperature, the heater tubes, transfer lines, and vapor-to-feed exchanger are 4-6 per cent chrome ½ per cent molybdenum, and the clay towers are surfaced with 2 in. of luminite cement.

During wartime it was unnecessary to exceed 680° to 700° F. clay-treating temperature since this was adequate to convert all mercaptans in the low-end-point (270° F.) 91-octane aviation gasoline. Completeness of desulfurization of the heavier portion was less effective than is currently attained at higher temperatures, but at that time motor-fuel octane was not so important a factor as now. Nevertheless, over a 2-year period ending with the war the carbon-steel transfer lines and vapor-feed exchanger showed only moderate corrosion.

After cancellation of aviation-gasoline contracts, it was desirable to treat more effectively the full-boiling-range gasoline, and consequently, clay temperature was raised to 725°-735° F. Corrosion became rapid and in a matter of 4 or 5 months it was necessary to renew the carbon-steel transfer lines from the heater to the clay towers, and it became evident that both shells and tubes of the G-fin vapor-to-feed exchanger would require renewal on the hot half. New sections of 4-6 per cent chrome G-fins were installed within another 6



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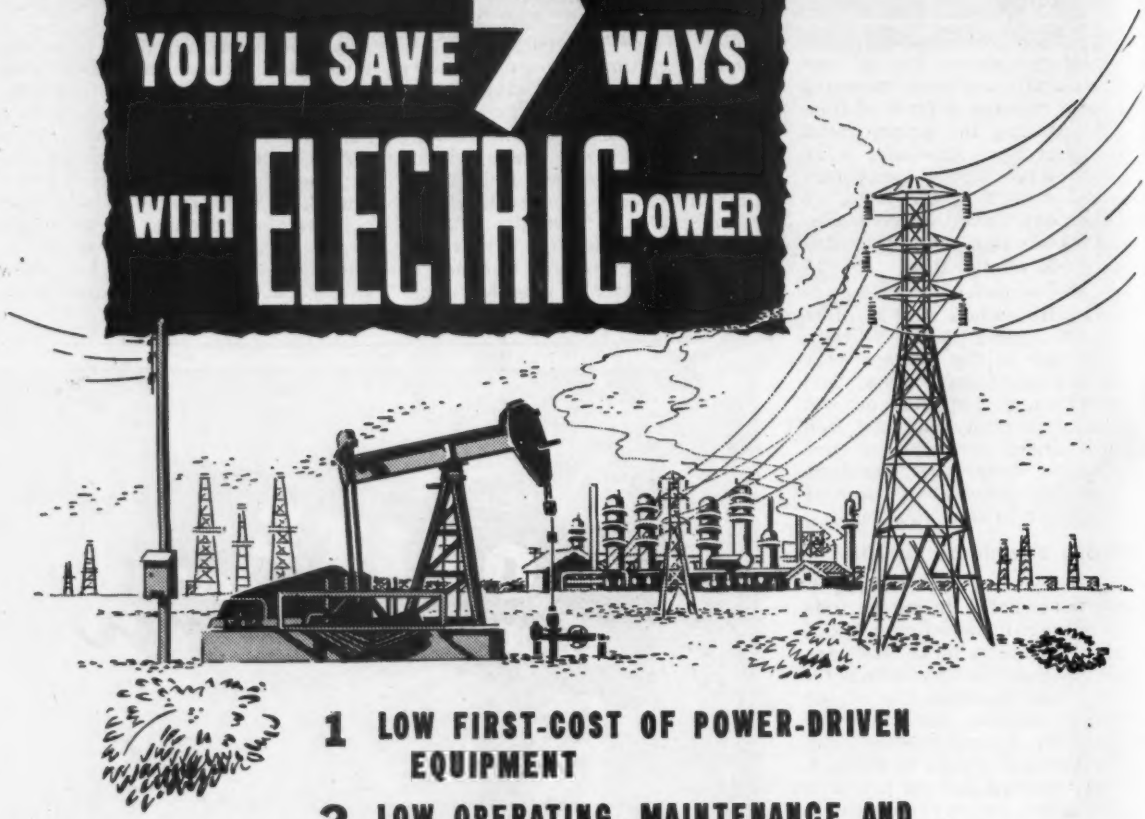

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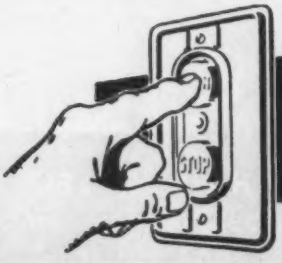

HOUSTON LIGHTING & POWER COMPANY

months, at the same time the clay towers were surfaced and the transfer lines replaced with 4-6 per cent chrome. Since that time the unit has shown little evidence of corrosion.

Overhead gasoline from the clay-treater rerun column is condensed in a shell-and-tube condenser having a steel shell and admiralty tubes. In 2 years there has been no corrosion either of shell or tubes of the exchanger or the steel reflux accumulator even though H_2S and water are both present. Absence of even traces of HCl probably accounts for this difference from the topping-unit overhead streams.

Cracking Unit

The cracking unit is a conventional two-coil unit with light-oil transfer temperatures of 1,000° F., and heavy oil of 900° F. Lime to the extent of ½ lb. per barrel of fresh feed is injected in the charge line to the main fractionator. Bottoms therefrom are charged to the heavy-oil heater. No lime is charged to the light-oil stills.

Average tube life in the radiant section is about 4 years and in the convection section 7 years for both the heavy and light-oil heaters.

One great advantage of the crude desalter seems to be in helping to keep clean the heavy-oil tubes and thereby increase the length of a run.

The reaction chamber is carbon steel and since 1939 it has shown only mild corrosion. The flash tower, however, showed more rapid corrosion and 3 years ago was surfaced with luminite cement. Transfer lines are 4-6 per cent chrome and last approximately 5 years.

The main fractionator column has shown considerable corrosion in the lower part up to about the 600° F. region and has been lined with 11-13 per cent chrome plate. Further, the side-to-side pans and bubble trays have been replaced with 11-13 per cent chrome. Condensers are submerged sections with admiralty tubes and cast-iron headers as in the topping unit. No difficulty is experienced in either the condensers or reflux accumulators since very little water is present on the predominate charge of topped crude.

Treating

Cracked gasoline is treated in a Unisol plant and leaves with about 0.002 per cent mercaptan sulfur. Until it was learned that use of U.O.P. No. 5 inhibitor instead of No. 4 caused the gasoline to sweeten in storage, it has been necessary to follow Unisol treatment with doctor treatment. Corrosion at the Unisol is always expected on the stripper and the lines carrying hot caustic soda. The stripper is a stress-relieved steel vessel with the lower 15 ft. nickel clad. The hot caustic lines and exchangers are also stress relieved.

Straightrun clay-desulfurized gasoline is doctor treated to remove a persistent remnant of unpleasant odor. Caustic and doctor treating in both the continuous units for straight-run gasoline as well as the batch agitators for distillates are entirely conventional and differ from that at other refineries only in the quantities of reagents required.

Storage

Corrosion in crude tanks has been particularly severe and some such tanks have been given a gunite concrete roof, floor, and bottom ring. Corrosion had been severe and in some cases had completely destroyed more than half the roof and deeply pitted the lower walls and bottoms. Some of the tanks were only 12 years old.

Guniting was commenced 4 years ago, and therefore, it is too soon to tell how well the concrete (luminite cement) will resist the corrosive effects of the crude and crude vapors. Although a few hairline cracks developed in the roofs soon after application, this has caused no apparent trouble. About half the floor applications leaked at first and then gradually stopped as the sediment settled from the crude. Although the bottoms and lowest ring had been sandblasted before the guniting, it appears almost impossible to be absolutely certain of no leaks.

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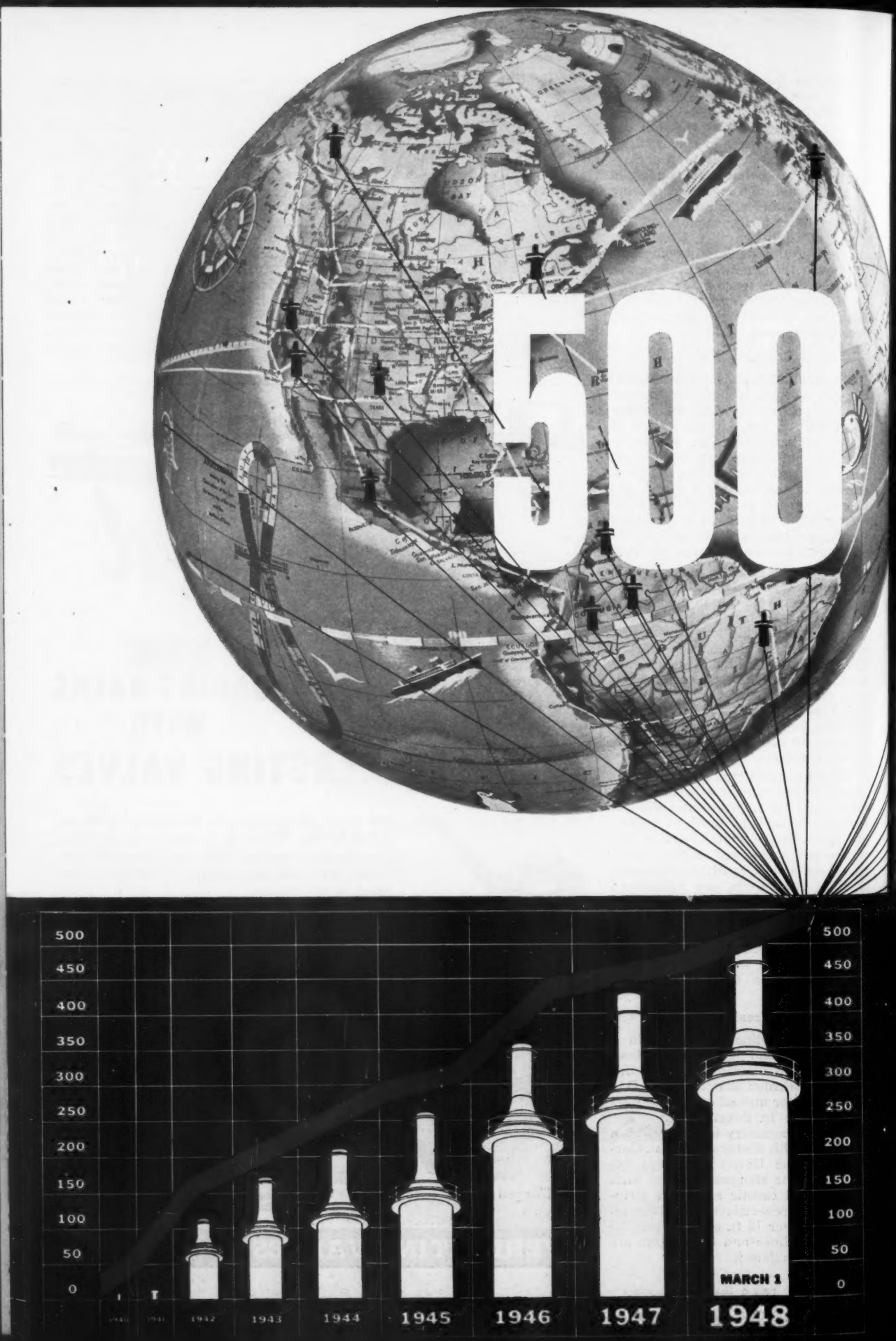
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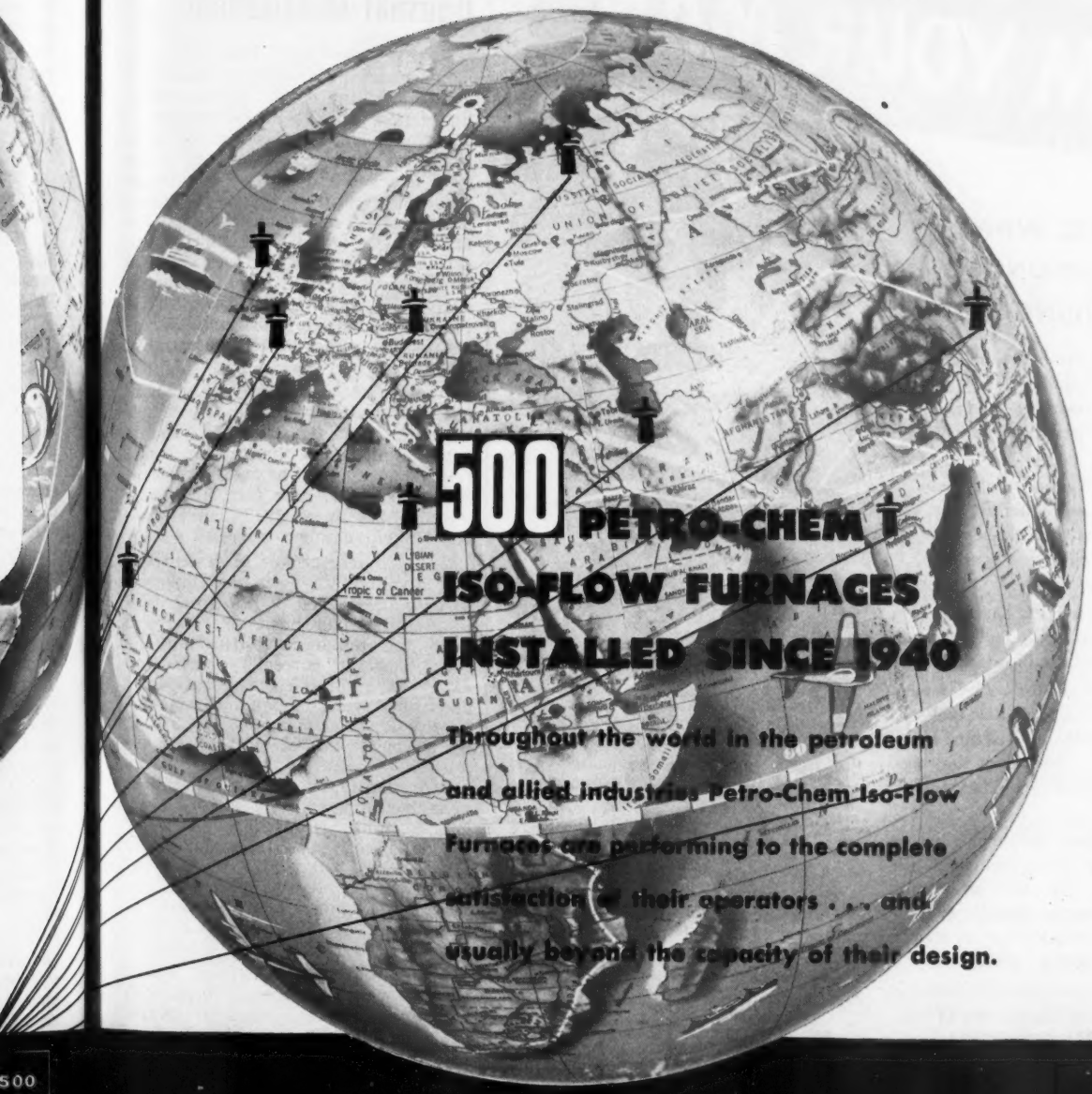
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Bell Refinery Makes Unusual Installatiom

(Continued from page 176)

haust steam heater which raises the gas temperature to 125° F. and assures liquid-free vapor to the compressor at all times. This temperature permits sufficient water vapor to pass to the poly charge, and so far eliminates fresh water injection. The compressor for this operation handles 200 M.c.f. of C_3 and C_4 per day at 115 psi. pressure and compresses it to 450 psi for discharge through two series-connected heat exchangers. The counter current flow in the exchangers is the outlet of No. 2 catalyst tower (J).

From these exchangers the poly charge passes through an exchanger where it is heated to 325° F. and is then admitted to the top of No. 1 catalyst tower (I). The catalyst towers are arranged to give four beds containing 1,200 lb. of U.O.P. solid phosphoric acid catalyst per bed.

The temperature of each bed can be controlled by recycle gas. However, to date the recycle to the fresh feed is all that has been necessary to keep the temperature through the four beds at correct values. One exception is in the middle of No. 1 catalyst tower where the temperature is lowered from 385° to 370° F. by a very small amount of recycle quench from a 10 by 2 by 12-in. pump, manifolded to the standby or quench pump, an 8 by 1½ by 10-in. simplex unit. No quench or water is added between No. 1 and No. 2 towers. The 410° to 370° F. drop between the towers is obtained by the line being uninsulated. Quench or water to control this temperature drop will be needed in warmer weather.

The outlet material from No. 2 catalyst tower exchanges heat with the poly charge, then is water cooled to 170° F. and delivered to the middle of the depropanizer (G) through a back-pressure regulator.

The overhead of the depropanizer (G) is a C_3 fraction made up of the fresh propane-make plus propane that is recycled for catalyst tower control plus overhead reflux. The fixed reflux ratio of 1 : 1 is based on the charge to tower (C). The overhead product is cooled in four sections of parallel coils (240 sq. ft.) then in three finned sections in parallel and then passes into the receiver for water settling.

The 8 by 1½ by 10-in. simplex pump is standby for either the depropanizer reflux pump or the 10 by 2 by 12-in. simplex liquid recycle pump but can be used at any time for quench to the side of the towers as needed. The 10 by 2 by 12-in. recycle pump delivers 4 to 5 g.p.m into the discharge of the polymerizing section compressor to lower the ole-

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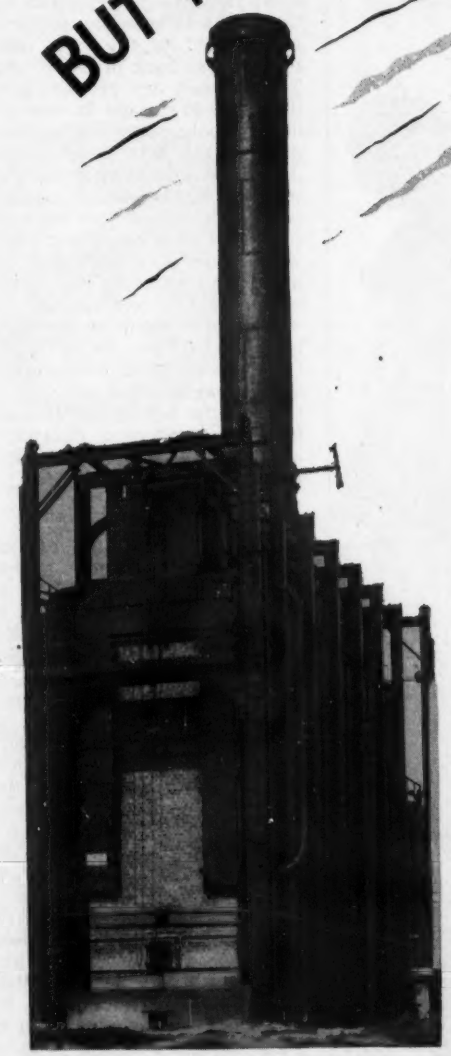

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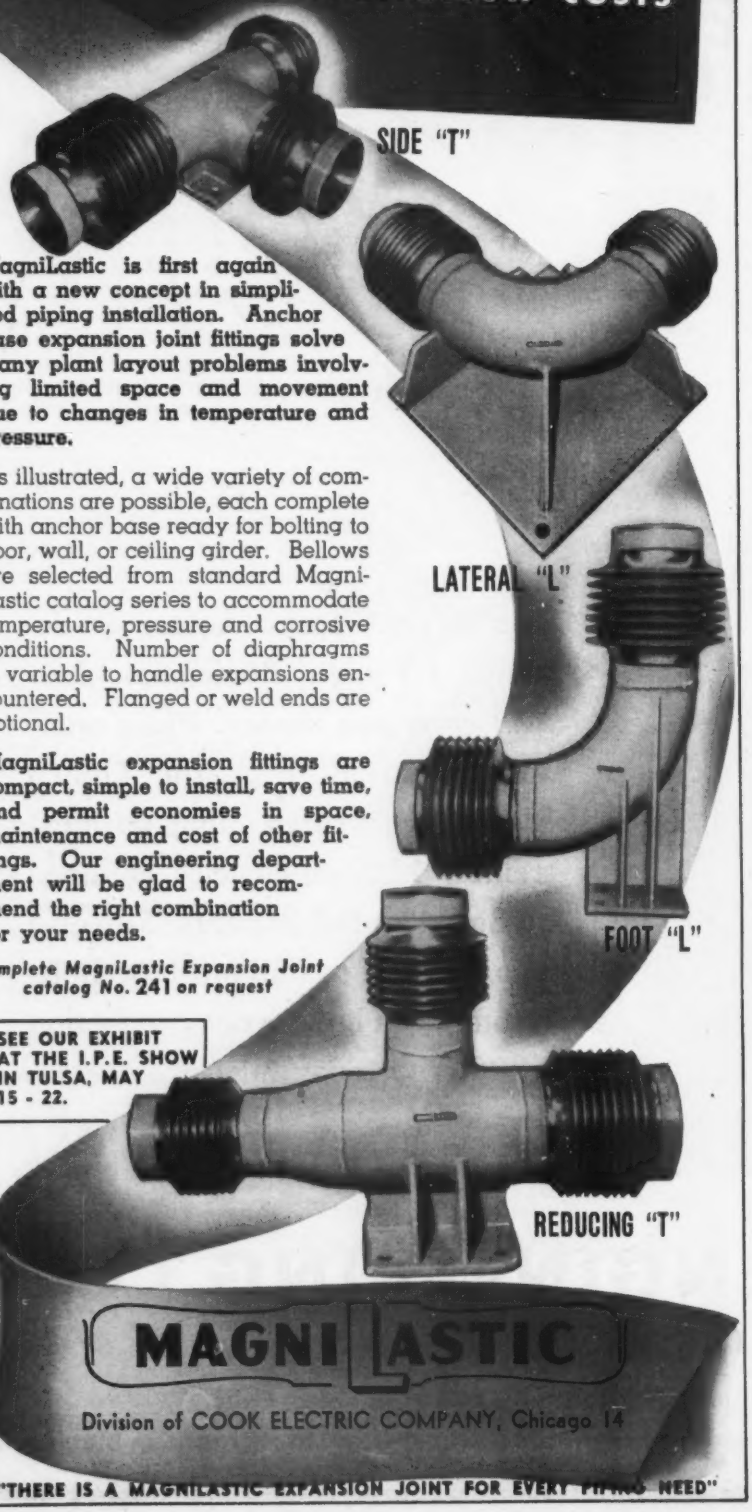
New expansion fittings save space, piping, and installation costs



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fin content of the fresh feed from approximately 42 to 18 per cent to prevent excessive temperature rises in the catalyst towers. The bottom temperature of the depropanizer is controlled to make an overhead product which contains less than 2 per cent C_4 residue. This operation assures maximum C_4 material to the bottom of the tower and to storage with the poly gasoline.

Overhead vapor pressure is controlled by the bottom temperature and absorber oil rate on column (C) which is acting as the deethanizer. From the C_3 receiver, which is full of liquid at all times, the propane make is admitted to the lime driers (H) through a back-pressure regulator. The finished dry propane goes from the driers to storage. In case of failure of the polymerization section compressor, the P.D. receiver gases go directly to an absorber not shown on the diagram. In case of failure of the poly plant or of the compressor at column (C) the gases from the caustic wash tower are admitted immediately by control valve to the outside absorber. This operation is continued if the poly plant is to be brought back on stream in a short time. Otherwise, column "C" is operated as a depropanizer and the total C_4 fraction off the top of the extension (D) is totally condensed, caustic washed, and put into the P.D. stream to the treating plant.

Deethanization

That a good job of deethanization is being accomplished is shown by the 200-lb. R.v.p. finished propane amounting to about 22 to 24 bbl. per day without using the compressor unit at column (C). Only traces of H_2S are in the C_3-C_4 poly charge, and the finished poly-gasoline is relatively sweet even without caustic wash of poly charge. Several times the caustic has been stopped because of various mechanical failures, yet the poly gasoline remained fairly sweet and caused no ill effects when doctor treated along with the P.D. gasoline. There is a 2 A.S.T.M. octane number increase in P.D. gasoline stream which is equivalent to 0.4 ml. TEL per gallon of P.D. when leading to 73 octane. Before the poly plant was in operation the maximum octane was 66 and usually around 65.5. Now the minimum octane number of the P.D plus poly plus butane is 68 and two finished treated P.D. tanks checked 68.9 by both refinery and Ethyl Corp.

Increased octane values can be accounted for without excessive R.v.p. of P.D. because the heretofore excess butane and propylene are now converted to low-R.v.p. high-blending-value components and all the stabilizer butanes plus propylene are blended with the P.D. rather than burned as fuel. The plant started to make poly gasoline on November 18, after about 60 days of actual construction.

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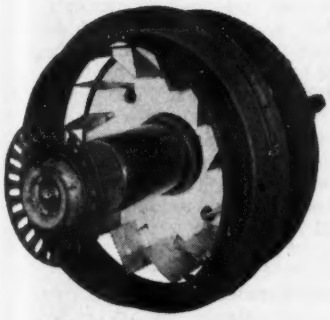

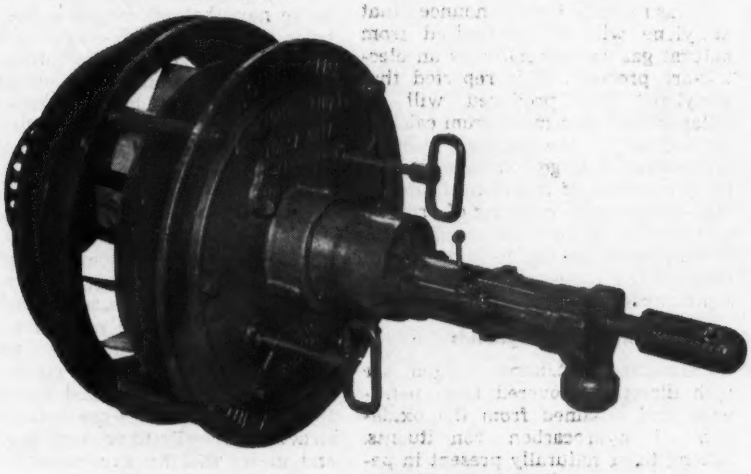

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TULSA - NEW YORK

Petrochemicals

(Continued from page 179)

and plastics. About 50 per cent of the total ethyl alcohol produced in the United States comes from petroleum or natural gas. Plastics, derived either wholly or in part from ethylene, include polyethylenes, most of the vinyl resins, ethyl cellulose and polystyrene.

Sales of the liquefied petroleum gases, propane and butanes, have more than doubled in the past 3 years. The proportional increase in use of these hydrocarbons for chemical manufacture is even greater. In 1944, 152 million gallons were marketed for this purpose whereas 415 million gallons were used in 1947[21].

It has recently been announced that acetylene will be synthesized from natural gas commercially by an electric-arc process[26]. It is reported that acetylene thus produced will be cheaper than that made from calcium carbide or by the German electric-arc process. A large commercial plant for production of acetylene from the high-temperature cracking of propane will also be in operation soon. These developments are highly important in view of the industrial and chemical significance of acetylene.

Oxygen Compounds

Chemicals containing oxygen are both directly recovered from petroleum and obtained from the oxidation of hydrocarbon constituents. Among those naturally present in petroleum are cresylic acids and naphthenic acids. Petroleum cresylic acids are recovered from cracked naphthas and gas oils. Their principal commercial applications at present are in resins, adhesives, surface coatings, gum inhibitors, flotation agents, disinfectants, metal cleaners, solvents, and insecticides[3]. In 1946, about 29 million pounds of naphthenic acids were extracted from petroleum[23]. These acids are used in fungicides, high-pressure lubricants, and rust preventatives. Their copper and zinc derivatives are used as paint driers and for treating textiles, in which they prevent deterioration from mildew and mold.

Oxygen derivatives are produced from petroleum hydrocarbons essentially by direct oxidation, by dehydrogenation with subsequent hydration or oxidation, by oxidation to carbon monoxide and hydrogen with subsequent hydrogenation of the carbon monoxide, and by chlorination with subsequent hydrolysis[24]. The largest volume of oxygenated petrochemicals are now produced by dehydrogenation followed by hydration or oxidation. Typical products derived from natural and refinery gases include ethyl, isopropyl and butyl alcohols, ethylene glycol, acetaldehyde, acetone, acetic acid, and acetic anhydride. It is now planned to manufacture ethyl alcohol by direct hydration of ethylene. The initial plant will produce 18 million gallons yearly.[19]

Direct oxidation of methane, ethane, propane, and butanes yields chiefly methanol, formaldehyde, and acetaldehyde. Higher-molecular-weight hydrocarbons are directly oxidized to fatty acids, alcohols, and ketones. The latter have a wide variety of applications as lubricant additives, rust inhibitors, plasticizers, or flotation agents.

The direct oxidation of ortho-xylene to phthalic anhydride is a development of consequence in the aromatic field. The first plant, which is in California, is now producing at the rate of 8 million pounds a year. This process will undoubtedly be expanded because naphthalene, formerly the sole basic material for this chemical, is in short supply. Present requirements for the plastics and resin industries are not being met by the production of 180 million pounds of phthalic anhydride from the present naphthalene plant capacity[28].

Of particular interest in the production of derivatives by oxidation of natural gas to carbon monoxide and hydrogen with subsequent hydrogenation of the carbon monoxide are the developments based on adaptations of a fluid flow catalytic process to the Fischer-Tropsch reaction. Two plants one processing 75 million cubic feet of natural gas per day and the other 100 million cubic feet are being constructed primarily to produce gasoline and diesel fuel by this method[5]. As byproducts, chemicals containing oxygen will be recovered at the rate of about 300 million pounds per year.

One of the most important products from the reaction of carbon monoxide and hydrogen is methanol of which 510 million pounds were produced in 1946.[29] Estimated production is 700 million and 860 million pounds for 1948 and 1949 respectively.[27] It is significant that while 71 per cent of the 1946 production was based on coke or coal, 77 per cent will come from natural gas in 1948. Capacity for methanol is being rapidly increased to meet demands for antifreeze and formaldehyde which at present are consuming 78 per cent of the methanol production. Formaldehyde production was 459 million pounds in 1946.[22]

Among the chemicals produced by chlorination of hydrocarbons followed by hydrolysis are allyl alcohol and glycerine. The basic raw material in this process is propylene. Allyl alcohol, an intermediate, is the basic ingredient for a new group of resins and plastics as well as a number of chemicals and pharmaceuticals. The synthetic production of glycerine is of extreme importance because of the shortage of fats. The initial plant with a capacity of about 35 million pounds per year is expected to begin operations in 1948.

Other oxidized products obtained by further processing of primary oxidation products include a wide variety of ketones, aldehydes, esters, ethers, and glycols. Important examples are ethylene glycol, ethylene oxide, diethyl ether, methyl ethyl ketone, glyoxal, ethyl acetate, acetic anhydride, and methyl methacrylate. A new but highly important development is the commercial production of acrolein, an extremely reactive and versatile intermediate.[25] About 20,000 lb. per month are now being made by the cracking of diallylether.

The possibilities of oxygen derivatives obtainable from the primary oxidation products of natural or refinery gases are many. The products available from acetaldehyde through production of aldols and acetals furnish an interesting example. The aldols are useful chemical intermediates for glycols, conjugated unsaturated aldehydes and ketones, and betahydroxy acids.[1] The acetals can be used as solvents and the cyclic acetals, dioxolanes, and dioxanes are useful in making resins. Commercial production of these chemicals on a tonnage basis will depend on industrial demands.

Halogen Compounds

Halogenated petroleum hydrocarbons comprise a long list of useful intermediates and finished products. The annual production of halogenated compounds is about 1.5 billion pounds per year,[11] a large part of which is petroleum-derived chemicals such as carbon tetrachloride, ethyl chloride, ethylene dichloride, and trichloroethylene.

One of the most important chemicals produced by halogenation of paraffins is difluorodichloromethane, popularly known as Freon and used as a refrigerant. Ethyl chloride, much of which is produced by treatment of ethylene with hydrochloric acid, is used in large quantities in the manufacture of tetraethyl lead. At one plant, over a billion pounds of ethylchloride have been made for this purpose.[6] Another ethylene derivative, ethylene dibromide, is used with tetraethyl lead. Ethylene dichloride is a basic material for Thiokol rubber. Vinyl chloride and vinylidene dichloride are basic materials for many plastics and resins.

Ethylene chlorohydrin and allyl chloride are highly important intermediates. The latter is made by a process in which a number of other useful products are obtained such as dichloropropane and dichloropropene which are the active ingredients of D-D. This product functions as a soil fumigant and is proving to be remarkably efficient in restoring blighted agricultural areas to fertility by ridding the soil of nematodes and wireworms.

Many of the new miracle insecticides are halogenated hydrocarbons, for example, D.D.T. [1,1,1-trichloro-

2,2-bis(p-chlorophenyl)-ethane] and gammexane (γ-1,2,3,4,5,6-hexachlorocyclohexane). Although much of the 47,000,000 lb. of D.D.T. and 780,000 lb. of gammexane produced in 1947 was derived from coal tar, the limitations of coal-tar production indicate a shift toward production from petroleum.[28] The petroleum industry is at present doing a 100-million-dollar-a-year business in insecticides and fungicides.[6] The newly developed weed killers, particularly those of the synthetic-hormone type, are predicted to become an even greater market for petroleum chemicals.

Chlorinated derivatives of paraffin wax are finding increasing use in flameproofing, in extreme-pressure lubricants, in cutting and drawing oils and in treating textiles to render them flame-resistant, and water and mildewproof.

Sulfur Compounds

Sulfur in petroleum and natural gas represents a huge tonnage. Pure sulfur is being recovered from an Arkansas natural gas which contains from 6 to 8 per cent hydrogen sulfide. The gas is partially oxidized to produce a mixture of sulfur dioxide and hydrogen sulfide which are reacted to form sulfur. One plant has produced 75,000 tons of sulfur having a market value of $1,250,000. In some refineries in the United States hydrogen sulfide is oxidized to sulfur dioxide for conversion to sulfuric acid.

Mercaptans are recovered from the gases and liquids obtained in the cracking of high-sulfur petroleum fractions. They are used in odorizing domestic fuel gases and in chemical manufacture. In 1946, over 6 million pounds of dodecyl mercaptan, which is used in synthetic rubber manufacture, were produced.[29] Dialkyldisulfides such as diamyl and dioctanyl disulfide are also byproducts of refining.

Thiophene is now being made from butane and sulfur. This product can be used in pharmaceuticals, dyestuffs, and resins. Another new development is a process for making carbon disulfide from natural gas and sulfur.[7] Commercial operation will begin this spring.

Dimethylsulfolane is being produced commercially from petroleum.[10] The sulfolanes are particularly valuable as solvents because of their noncorrosive character, high selectivity, and chemical inertness.

The most outstanding sulfur derivatives of petroleum are the surface-active agents. Total production of all synthetic detergents in 1947 was about 600 million pounds per year[13] which contain about 240 million pounds of surface-active agents.[23] The petroleum derived surface-active agents are principally a group classified as petroleum sulfonates, alkyl sulfonates, and alkyl aryl sulfonates with alkyl chains of 12 to 18 carbon atoms in length. The alkyl aryl sulfonates comprise about 40 per cent of the synthetic surface-active agents manufactured and the alkyl sulfonates about 10 per cent. The future of synthetic detergents is most promising. Industry is looking forward to a 1 billion pounds per year production. Progress in this field cannot be measured in quantity alone as the new products have many valuable properties not found in soap.

One of the most interesting sulfur petrochemicals is polyethylene polysulfide, an insecticide and fungicide. When sprayed on plants in aqueous solution it forms a rubber-like web which actually seals out insects and fungi. Other important sulfur chemicals now manufactured include Thiokol rubber from reaction of ethylene dichloride with sodium polysulfide, and sulfone resins from olefins and sulfur dioxide.

Nitrogen Compounds

Ammonia and ammonium nitrate are produced as byproducts of refining operations. Ammonia is synthesized from hydrogen obtained from the high-temperature cracking of natural or refinery gas and nitrogen from liquid air fractionation. Ammonium nitrate is made by oxidation of ammonia to nitric acid and subsequent reaction with ammonia. These operations provide a large volume of the nation's fertilizer requirements. A single plant in Arkansas has an annual capacity of over 330 million pounds of ammonium nitrate and 180 million pounds of anhydrous ammonia which is sufficient to meet 11 per cent of the United States' requirements.[26]

The nitration of petroleum hydrocarbons provides intermediates for a host of useful products. The lower nitroparaffins and alkylamines through C_5 are being produced commercially. The alkylamines have grown in importance for use as intermediates for rubber chemicals and fungicides. Nitrocyclohexane and cyclohexylamine are also available. These compounds have a variety of possible uses in textile processing, pharmaceuticals, insecticides, and corrosion inhibitors.

Among the highly important nitrogen derivatives during the war were the xylidines which were added to motor fuels to increase the antiknock rating. Addition of xylidine is capable of extending considerably the supply of aviation gasoline.[9] Production during the war reached 150,000 lb. per day.[3] It is believed that xylidines will also be useful in the manufacture of dyes and intermediates, as accelerators for rubber, wood preservatives, wetting agents, antioxidants for paint pigments, and frothing agents in ore dressing.[4]

Ethanolamine, isopropanolamine, and related compounds such as triethanolamine are made from the reaction of corresponding oxides with ammonia. Some of their uses are in cosmetics and detergents. In 1946, over 3.6 million pounds of surface-active agents for detergents were based on nitrogen-containing aliphatics.[20]

Acetonitrile, propionitrile, n-butyronitrile and acrylonitrile, now made from petroleum, are important chemical intermediates. Acrylonitrile is used as an intermediate for acrylate resins and in the manufacture of GR-A type rubber of which over 13.6 million pounds were produced in 1946.[25]

Ethyleneamines have a diversity of uses. Ethylenediamine, for example, is utilized in the preparation of fungicides, insecticides, dyes, waxes, medicines, and in a process whereby asphalt may be laid on wet surfaces. Ethylenediamine tartrate crystals are replacing quartz in telephone cables. It makes possible the transmission of 500 conversations at the same time over a single cable 2 in. in diameter and is superior to quartz because of its greater uniformity and easier processing.[11]

Benzonitrile is the first of a series of aryl alkyl nitriles to be made from petroleum.[17] This development utilizes toluene and ammonia, both of which were in large-scale production for the war. It will have numerous applications because of its high reactivity with a great number of chemicals for the synthesis of rubber, resins, plastics, dyestuffs, and pharmaceuticals.

Nylon can now be made from petroleum as the result of a process using cyclohexane as starting material. It may be expected that this source will be used more and more extensively. A large plant is being constructed in the Texas Gulf area to manufacture nylon salt from petroleum.

Growth Abroad

Petrochemical manufacture is also being increased abroad as chemical requirements can no longer be met by coal-tar production. In England, a plant is being constructed to use the Catarole process in which olefin gases and aromatics are produced catalytically from petroleum distillate.[14] The first installation will have a capacity of 100 million pounds of chemicals per year but expansion to 200 million is being allowed for. Another company will complete a plant this year with an initial annual production of 48 million pounds of olefins, aromatics, and oxidation products.[22] Two other companies are installing plants for the production of olefins. One of these will have a capacity of about 60 million pounds of ethylene per year.

Additions to another English plant now producing sodium alkyl sulfates will bring its detergent production up to 100 million pounds annually.[24] A plant manufacturing insecticides and fungicides from petroleum will be expanded to 60 million pounds capacity. Auxiliary to these developments are

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new research laboratories and an experimental farm. In Holland, a new chemical industry based on petroleum is also being established. To be completed this year are a plant for the production of 4 million pounds of plastics and resins and one for the manufacture of 50 million pounds of detergents annually. Expansion of a synthetic-nitrate plant is planned to reach 102 million pounds by 1949. This project is of considerable importance because of the shortage of fertilizer in Holland.

Future Trends

In predicting the future for chemicals from petroleum and natural gas, it is necessary to summarize present allocations. Butadiene accounts for about 30 per cent of the present production of raw materials for synthetic organic chemicals. It is being used for the production of synthetic rubber which has been curtailed since the end of the war. The availability of ample supplies of natural rubber, however, probably will not cause a drop in petrochemical consumption for two reasons.

Butadiene is made from butylene which is in high demand for other products. Secondly, it is certain that a synthetic rubber industry will be maintained in the interests of national security. Over 1.3 billion pounds of C_3 and C_4 hydrocarbons other than butadiene are being produced annually for chemicals. An increase in production of these compounds can be expected as almost any organic chemical known can be made from them. The present ethylene production is not sufficient to meet requirements. Inasmuch as ethyl alcohol is becoming increasingly dependent on ethylene as raw material, demand may be expected to exceed supply for a number of years. Aromatics represent about 600 million pounds of the petrochemical production with greater demand ahead.

Examination of the outlets for these products also indicates a growing industry. The principal products based on petrochemicals are rubber, plastics, resins, detergents, and chemical intermediates. Although 1946 production of synthetic rubber had dropped from 1945, plastics, resins, detergents, and the principal chemical intermediates from petroleum had increased.

Synthetic rubber is yet in its primary stages from a technical standpoint. Increasing research will doubtless open new markets for special products. Butyl rubber (GR-I) provides an excellent example of the potentialities. As material for tire inner tubes it is far superior to natural rubber because diffusion of air is about one-tenth of that through natural rubber and it has superior age and tear resistance. Research also indicates that butyl rubber is excellent material for tractor tires where deterioration from oxidation and light are important factors.

Bulk of the 1.7 billion pounds of elastomers produced in 1946 for synthetic rubber was derived from petroleum and natural gas, and it is probable that an increasing percentage of total production will come from these sources.

The plastics and resin industries comprise one of the largest markets for petrochemicals. In 1946, plastics and resins production was 994 million pounds[13] and estimates for 1947 indicated a 13 per cent higher demand.[13] Consumption in 1947 of polystyrene, which requires large amounts of ethylene, increased 37 per cent over 1946 or to 92 million pounds.[14] It is expected that capacity will be expanded to 200 million pounds by the end of 1948.

The present shortage of urea and melamine resins can be overcome by increased production of formaldehyde from petroleum. Over 200 million pounds of phenolic resins and plastics were produced in 1947. Over 60 per cent of the total phenol production was required for resins, and phenol demand for all uses is much greater than supplies. Both raw-material sources and plant capacity must be expanded. The present benzene situation indicates that petroleum sources will necessarily become a growing factor in phenol production.

Petroleum also supplied large quantities of the material for the 180 million pounds of vinyl resins produced in 1947, and demand is not yet satisfied in this field. The greatest problem is a shortage of plasticizers, many of which are petroleum products. The 1948 production of polyethylene is anticipated to be 50 million pounds. Other petroleum-derived plastics and resins will be produced in high tonnage as source material becomes available and plant capacity is increased.

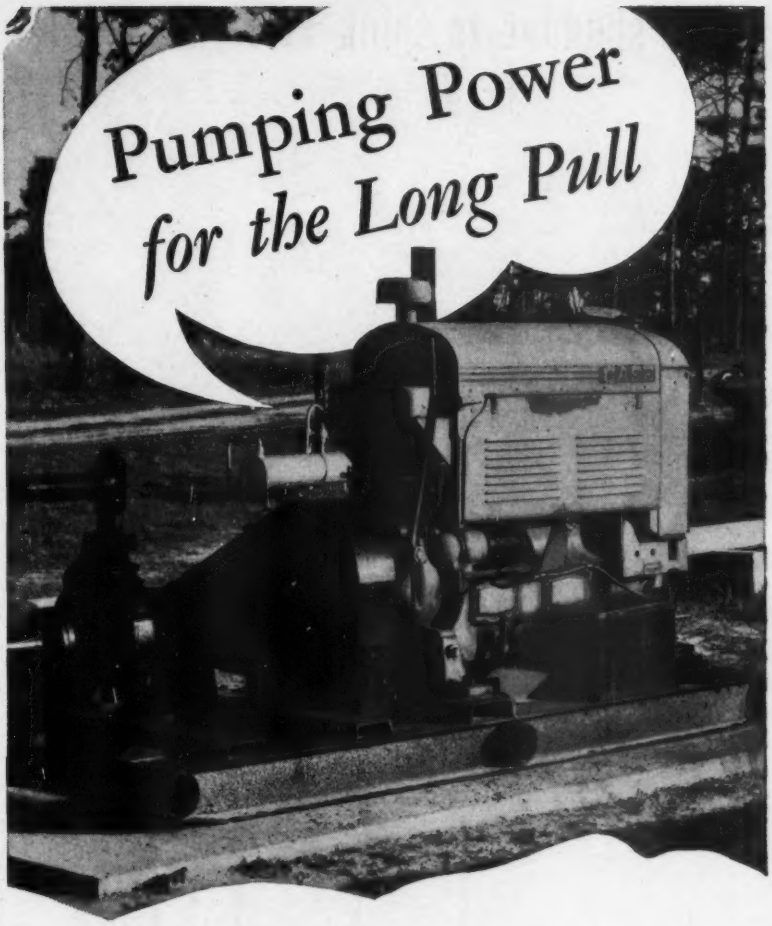
The detergent field is in a state of rapid growth. Indications are that this industry will double production in less than a decade. Much of the 240 million pounds of surface-active agents produced in 1946 was based on petroleum and a larger potential market is assured.

The production of oxidation products from petroleum and natural gas promises a growing market. Present requirements can be seen from the quantities of some of the more important oxidized chemicals (those in over 100 million pounds per year production) made in 1946 and 1947 as shown in Table 1.

TABLE 1[12,20]

Synthetic organic chemicals:*	1946 (millions of lb.)	1947 (millions of lb.)
Acetaldehyde	352	...
Acetic acid	285	360
Acetic anhydride	522	623
Acetone	336	396
Butyl alcohols	231	...
Ethylene glycol	192	227
Formaldehyde	459	514
Isopropylalcohol	543	...
Methanol	510	542

*From all sources.



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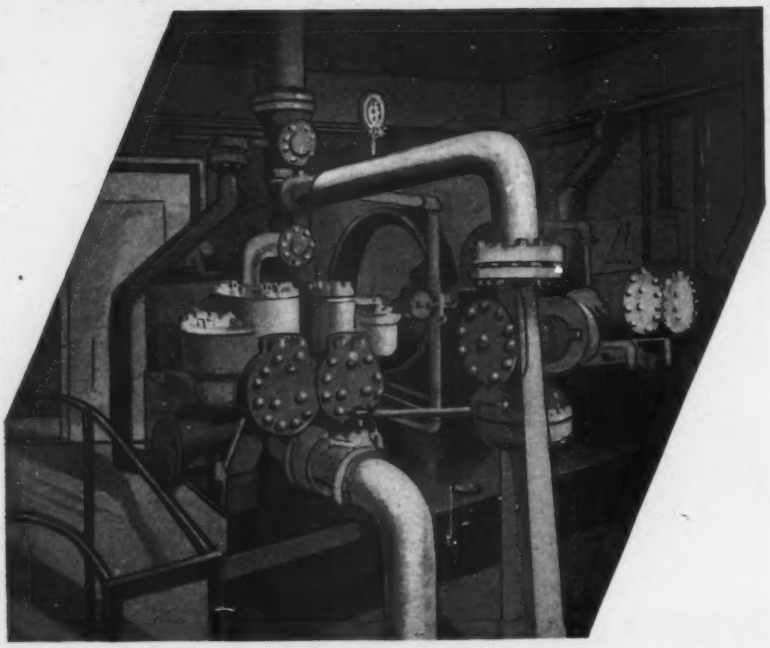

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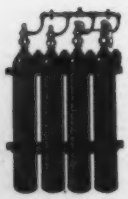

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These compounds are being made from petroleum and natural gas, and within a few years, it is highly probable that the production will be derived essentially from these sources.

Although present capacity provides for an annual output of over 1 billion pounds of benzene and 350 million pounds of naphthalene,[23] primarily from coal tar, greater amounts are needed. Coal tar as a source is limited by the extent of byproduct coke-oven operations, and petroleum cracking seems to be the only permanent solution to satisfy demands. Use of new low-cost oxygen processes in the steel industry will probably reduce the amount of coal tar even further.

A rapidly expanding petrochemical industry may be forecast not alone from the aliphatic chemical requirements which are primarily responsible for its development, but also from anticipated aromatic demands. Although present excess of demand over supply can be attributed partially to pent-up demands and delays in construction of new plants, there is little indication that peak production will be reached for a number of years. Petrochemical research is being carried out on a larger scale than ever before with the result that new markets are being constantly opened.

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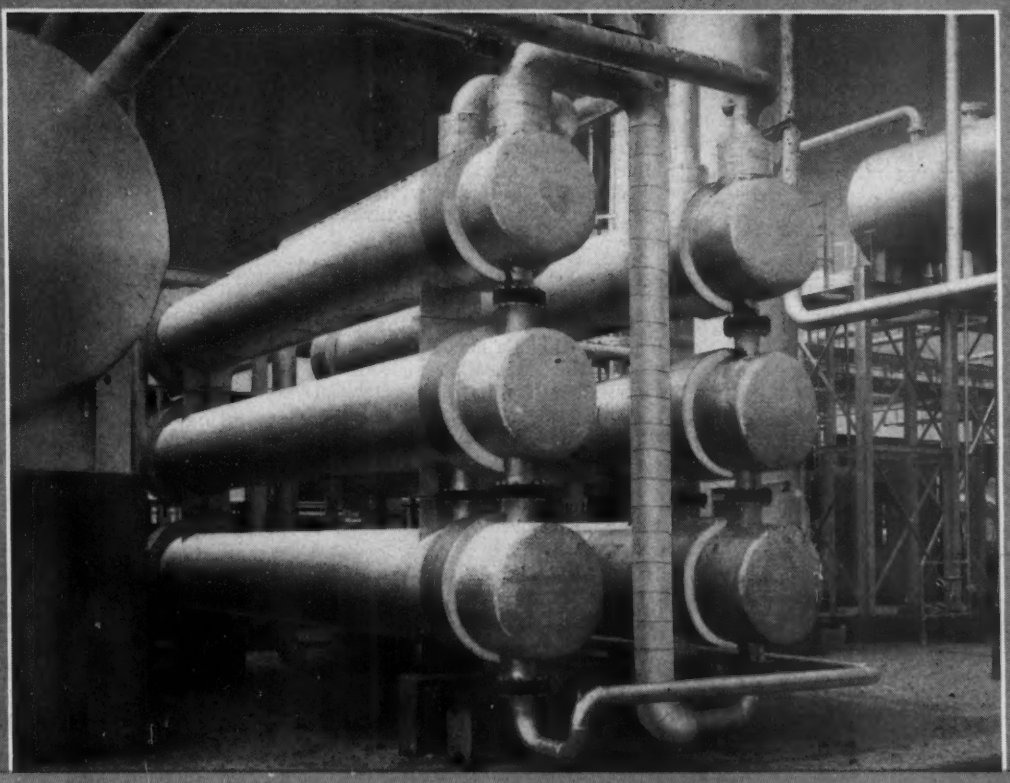

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Principles in Design of A Valve Repair Shop

(Continued from page 189)

grinding is done by means of a tapered fixture having an angle complimentary to that of the disk (see Fig. 12). In case a new disk is not available, the old disk may be built up with weld metal and finished in this manner. After grinding, the disk is given a fine finish by lapping. The seating of disks and body rings is then checked with prussian blue in the same manner as described above for valves reworked by lapping alone.

In the installation of new body seats and disks great care must be taken to be sure that the replacement parts are made of the same material as the old seats. Tags are usually attached to the valves denoting the trim material. Not too infrequently, however, these tags are lost, and the material of the seats and disks must be ascertained. Some metals can be recognized by their appearance and magnetic properties. However, if there is any doubt, the service should be checked to be sure that the material used will be suitable.

The valve stem is inspected. Sometimes it is found pitted from corrosion in the packing area. This pitting can lead to leakage past the packing, and consequently it is removed by polishing with very fine emery cloth. If the pitting is too deep to remove, the stem is replaced. The valve stem threads are also examined closely, as they can be damaged if too much force is exerted in attempting to open or close a frozen valve.

The gasket faces are given a close inspection, and it is sometimes necessary to reface them if they are badly nicked or burred. Care must be taken in refacing to maintain adequate flange thickness. Sheet gaskets are always replaced; however, ring-type gaskets are reused if they are in good condition. Questionable ring gaskets are frequently reused by lapping in place to restore satisfactory seating surfaces.

The valve is now reassembled and a suitable lubricant is used on all the studs. After reassembly, the valve is given a hydraulic pressure test at twice the rated pressure of the valve. If it does not leak it is ready to return to the unit.

Fig. 2 shows the cross-section of a typical relief valve and the part nomenclature given there will be used throughout the discussion on relief valves. In the repair of this valve, it would first be inspected for wall thickness, cleaned, and stripped down in the same manner as described for gate valves.

The main factor in repairing relief valves is to obtain a good sealing surface between the nozzle and the disk. This is done in a manner very similar to that used in obtaining a good sealing surface between the body rings and the disk in gate-valve repair. If the wear is not too great, the nozzle is refinished by means of a hand lapping block using the necessary sequence of lapping compounds. The disk is refinished in the same manner on either a bench or a rotary lapping plate. The sealing surfaces are then tested by coating the surface of the disk lightly with prussian blue, dropping it in place through the guide, oscillating it several times, and inspecting the ring formed on both the nozzle and the disk. If the rings on both parts are continuous, the valve will usually be tight.

In cases where the nozzle seat is too badly worn to refinish by lapping, several alternative refinishing methods can be used:

1. The entire valve can be mounted in a lathe and with the nozzle and the body running perfectly true the seat can be remachined.

2. When the nozzle can be removed from the valve, it may be mounted in a lathe and after being trued up the seat can be remachined.

3. Special nozzle reseating equipment, which is available from some manufacturers, may be used. Fig. 13 shows a machine of this type installed on the valve. When these special reseating machines are available, they save considerable time and do an excellent reseating job.

After the nozzle seat has been remachined by any of the above methods, it must be lapped until the desired finish is obtained.

The valve disks are also remachined when the sealing surface becomes too badly worn to repair by lapping. When this is done it is essential that the seating surface be cut perfectly flat and perpendicular to the center line of the disk. Just enough metal should be removed to produce a good surface. The seat must then be lapped to give the proper surface finish. For remachining either the nozzle or disk seats contour gages are usually available from the valve manufacturers. After the nozzle and disk have been remachined and lapped, they should be checked with prussian blue as described above.

The ball seat between the disk and the spindle, the outside diameter of the disk, and the inside diameter of the guide assure that the spring force will not cock the disk if the spindle is not exactly perpendicular to the sealing surfaces. Therefore, these parts are carefully examined and reworked to be sure that they function properly.

The valve springs are inspected closely to detect any nicks or fatigue cracks which sometimes occur in relief valve springs. If nicks are found, they are stoned out to a smooth radius to eliminate the stress concentration at this point. Should fatigue cracks be found the springs are replaced. The springs are oiled or greased prior to installation. Special coatings may be required to prevent corrosion.

The gaskets and gasket faces are inspected in the same manner as described for gate valves. The valve is then reassembled and is ready for pressure testing.

The pressure testing and adjusting of relief valves should be done with water if the valves are to operate in hydraulic service, and with air if the valves operate in vapor or gas service. Since relief valves are tested at room temperature and operate at some other temperature, it is necessary to correct for this temperature difference. The valve manufacturers will supply this information. The adjusting bolt at the top of the relief valve is used to set the popoff pressure. The adjusting ring is used to give a sharp opening action.

Repair of Plug Cocks

The cross-section of a typical plug cock is shown in Fig. 3. The inspection, cleaning, and disassembly of plug cocks is carried out in the same manner as described for gate valves. The plug and body seat are subject to corrosion, erosion, galling, scoring, and seizing. If the damage to the sealing surfaces is not too severe, it may be possible to lap it out. This is done by applying lapping compound directly to the plug and lapping it into the body with an oscillating motion.

If the wear is too severe an oversize plug must be installed. The replacement plugs are supplied by the vendor completely machined except that the diameter of the taper is left oversize to provide for fitting. If the body seat is in good condition, fitting is accomplished by grinding down the plug as it is desired to keep the body wall as thick as possible. However, if the body seat is worn the fitting is accomplished by regrinding the body. The body can be refinished either in an i.d. grinder or with grinding attachments that can be mounted on a conventional engine lathe. Fig. 14 shows a plug cock body being refinished in a lathe using a grinding attachment. The final step in fitting a new plug is that of lapping it into the body until the desired surface finish is obtained. To check the seating, the plug is lightly coated with prussian blue and rotated back and forth a fraction of a turn within the

body. The contact within the plug can then be examined.

Plugs for steel cocks are usually furnished soft to permit machining to size, and must be heat treated before installation to prevent seizing in operation. These plugs must be ground after hardening and before lapping into the body.

The gasket and gasket faces are inspected and repaired the same as for gate valves. After the plug cock is reassembled, it is hydrostatically tested at twice the rated pressure of the valve.

Repair of Check Valves

The cross-section of a typical check valve is shown in Fig. 4. The inspection, cleaning, and disassembly of check valves is carried out in the same manner as for gate valves.

The body rings and the valve disk are usually replaceable in check valves. Replacement is made if the wear is too great to be lapped out. If the wear is not too great to be repaired by lapping, the body ring is lapped smooth using a hand lapping block while the disk is removed and lapped on a bench or rotary lapping plate. Grinding compounds are used in the same sequence as described for gate valves. A check on the seat is made by lightly coating the disk with prussian blue, slipping it in the guide, and rotating it back and forth a fraction of a turn against the body ring. When a continuous seat is obtained, it is almost certain that the valve will be tight.

The gaskets and gasket surfaces are examined and refaced in the same manner as described for gate valves. After reassembly, the valve is hydraulically pressure tested at twice the rated pressure of the valve.

Repair of Control Valves

A cross-section of a typical control valve is shown in Fig. 5. There are a wide variety of different types of control valves actuated by different sources of power; such as, diaphragms, bourdon tubes, hydraulic or pneumatic cylinders, etc. The energizing portion of a control valve is usually repaired by instrument mechanics and only the fluid end of the valve is repaired in the valve-repair shop. The inspection, cleaning and disassembly of the valve is similar to that described for gate valves. Usually the shape of the ports in a control valve is very important. Therefore, when wear occurs in a control valve the worn parts are usually replaced rather than repaired. Where the parts are repaired, the procedure varies depending upon the type of valve, but in general the principles followed are typical of repair methods used on other valves.

Fig. 6 shows the cross-section of a typical globe valve. A comparison of Fig. 1 and Fig. 6 shows that the globe and gate valves are similar in construction with the exception of the sealing surfaces. The repair of the two kinds of valves is also identical with the exception of the work done on the sealing surfaces.

If the body seat ring and the disk of the globe valve are not too badly worn, the lisk is lapped directly into the body ring until a continuous seat is obtained. In cases of wear too great to be removed by lapping, but not severe enough to warrant discarding the disk and body ring, both parts may be refaced in a lathe or a grinder depending upon the hardness of the parts. This refacing should be followed by lapping until a continuous seat of the desired surface finish is obtained.

Component Parts of a Valve Repair Shop

From the above discussion of typical repair methods for all six categories of valves it is apparent that a valve repair shop can be broken down into five sections: (1) cleaning section, (2) repair section, (3) spare-parts section, (4) machine tool section, (5) pressure test section. Each of these sections will be discussed below.

1. Cleaning section.—The first operation after valves arrive at the valve repair shop is to thoroughly clean them. This cleaning makes disassembly easier, and permits ready inspection of the component valve parts. There is usually steam available in a refinery at about 100 psi. By supplying a suitable hose and nozzle, and by making provisions to carry out the vapor and catch the condensate, a simple valve-cleaning arrangement can be made.

Another method of cleaning valves is to use an open tank filled with a solvent, such as gas oil, kerosine, or with oakite. This tank should have sufficient capacify to handle the largest valve to be repaired. A chain hoist or some similar device should be provided to immerse the valve in the tank and to remove it.

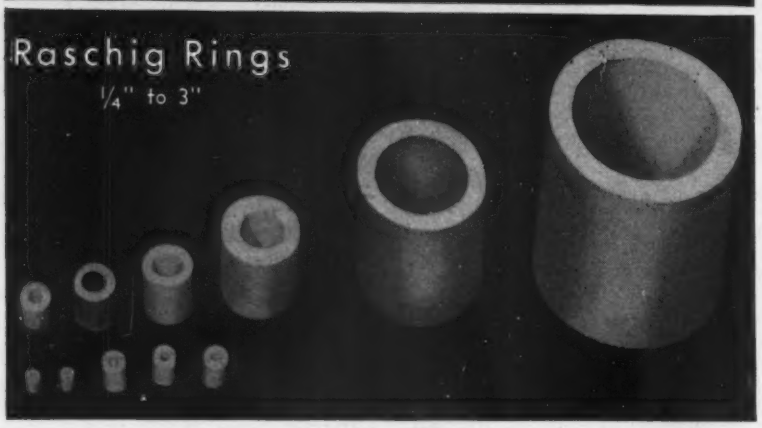
2. Repair section.—The repair section of the shop should provide ample working space and a method for firmly holding the valve while the repair is being made. It has been found that tables with 1¼-in. thick steel plate tops and with legs of 4-in. steel pipe make a rugged work bench. These tables should be equipped with strong vises capable of holding most of the valves to be repaired. Several slots can be cut through the table so that the valve may be bolted directly to the table top if it is so desired. Fig. 7 shows a valve being held in a vise ready for repair, and Fig. 11 shows a valve firmly bolted to the table through the slots. The area of the table top should be determined by the type of valves that are to be repaired. Equipment must be provided for lifting the valves from the floor to the work table. Chain falls, either hand or power operated, are very useful for this operation. In a large shop a fork lift truck greatly expedites the handling of valves.

For disassembly purposes a complete set of box wrenches should be provided, along with an impact wrench with all of the various sizes of sockets. Since there is a considerable amount of hand fitting to be done, many different kinds of files should be available. A very useful piece of equipment is a welding torch for applying heat to burn the coke out of valves and to crack the coke from behind the screw threads of the body rings by heating and allowing to cool. This torch can also be used to cut bonnet attaching studs in half when they are so badly corroded that removal of the attaching nut is difficult.

A series of bench lapping plates are required to produce a flat surface on valve disks or other parts that are removed from the body for lapping. Each of these plates should be coated with a different grade of lapping compound as it is not good practice to use different grades on the same plate. A wide variety of ring shaped hand lapping blocks made of a good grade of annealed cast iron are needed for refacing sealing surfaces that remain in the valve body during repair. It is good practice to use only one grade of lapping compound on each hand lapping plate. Since it is essential that hand lapping blocks remain perfectly flat at all times, it is good practice to check them before use on the proper bench lapping plate. This is done by lapping the block several times and noting if the entire surface is touching the plate. By the use of rotary lapping machines, as shown in Fig. 9, a considerable time saving over the use of bench lapping plates can be realized.

3. Machine tool section.—It is essential that machine tool facilities are available to a valve repair shop. Several different sizes of lathes are needed to reface and reseat the many different kinds and types of valves. A small engine lathe is needed for making spindles and other parts for smaller valves. Oversize valve gates require facing on a surface grinder. Oversize plug cocks must be ground down and the tapered seat in the plug cock body requires grinding. It is a good investment to purchase relief valve reseating tools if any quantity of relief valves are to be maintained.

4. Spare-parts section.—Since it is necessary to stock replacement parts, a well-organized spare-parts system is needed. Parts for identical valves are often made of different materials and installation of the improper part often results in unsatisfactory operation. A storage-bin system with a card file functions satisfactorily



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where provision is made for reordering of parts when the quantity in stock falls to a predetermined minimum.

5. Pressure test section.—Valves in fluid service are pressure tested with water and relief valves in vapor or gas service are pressure tested with air. In both cases the pressure can be obtained by a water pump. There are several different pumping arrangements that could be used to build up this variable pressure:

(a) A hand-operated pump similar to a hydraulic jack.

(b) A steam or air-operated power pump having a large power piston directly connected to a small fluid piston. The pressure is controlled by throttling the steam or air going to the power cylinder.

(c) A gear-type pump having the pressure controlled by a throttling valve in a bypass line between the discharge and suction sides of the pump.

These pumps can be arranged to discharge into a manifold with take-offs leading to several flanges on which any of the valves being repaired can be mounted. There should be a pressure gage in the line to indicate the test pressure.

To apply air pressure to a relief valve by the use of high-pressure water, the valve is mounted on top of a riser pipe about 5 ft. high and 6 in. in diameter. The high-pressure water is admitted at the bottom of the pipe and compresses the air ahead of it till the relief valve pops. Since it may be necessary to repeat this test several times before the popoff pressure can be properly set, the riser pipe is provided with a drain valve at the bottom and an air vent valve at the top.

For all hydraulic testing a filter should be provided to remove all particles of foreign material from the fluid used for testing. This is essential since any material reaching the valve seats can result in leakage and damage to the seating surfaces.

Conclusion

It has been the purpose of this article to show that valve repair can best be handled in a job shop manner and to discuss how this work can be accomplished. The actual design and layout of a particular valve-repair shop depends upon the manner and size of valves to be repaired, the amount of space allocated to the shop, and the available machine-tool facilities. The equipment selected should be sufficiently flexible to repair all the valves that pass through the shop. The layout should allow sufficient working space to handle the largest valves to be repaired and should provide for rapid handling of the valves in and out of the shop and between the various sections of the shop.

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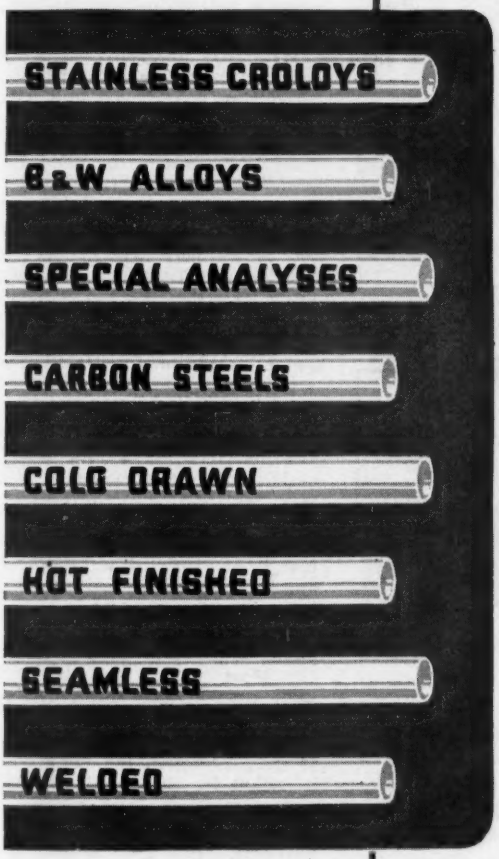

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shop is a valuable asset to an oil refinery for several reasons. It is difficult and expensive to maintain a complete and adequate stock of replacement valves due to the wide variety of valves in use in, an oil industry. A valve-repair shop assures adequate protection on valve replacements with a minimum loss of time and with a greatly reduced value inventory. The useful life of valves is also considerably extended in many cases. Frequently the rapid repair or replacement of valves is a critical shutdown item in the overhaul of a major unit. The rapid repair of valves in such cases may often accelerate the return of the unit to operation. In view of the above advantages, provision for a completely equipped valve repair shop capable of the rapid and efficient overhauling of valves is worthy of the consideration of any oil refinery.

Maintenance and Repair of Valves

(Continued from page 191)

Remove the bonnet assembly and examine and clean all parts thoroughly. Remove stem from bonnet, place in vice and unscrew disk stem ring. (Fig. 5.)

Lift out stem, insert a spacer or coin inside the disk. (Fig. 6.)

Replace stem and tighten disk stem ring. The spacer takes up the clearance between the disk and the stem. Apply an emery-base grinding compound on both disk and seat. A light coating of compound is all that is necessary. (Fig. 7.)

Place body and bonnet together and if the valve is a union bonnet design the union ring should be screwed on, but not tight. (Fig. 8). In case of a bolted bonnet insert a couple of bolts, but do not tighten the bolts. This will provide a guide for the stem.

With firm hold on hand wheel applying pressure oscillate steadily until all pitting is removed and a continuous smooth bearing on the seating surface is obtained. Grind no more than is necessary for good bearing. When grinding is completed, clean the disk seat and body of all compound. Again use prussian blue similar to the gate valve to determine if a good bearing has been obtained. Valve can then be reassembled, but be sure to remove the spacer from the disk so that it will have free swivel action on the stem.

When the body seat rings have been damaged beyond repair, they should be replaced. This can be accomplished using a tool specifically designed for the purpose, or by means of a bar fitted into the lugs or slots in the body ring. Before using valve it is advisable to give it a pressure test to be sure of tightness of seat and stuffing box.

In conclusion are made the following suggestions on installing gate, globe, angle, and check valves.

1. Most valves can be installed with stem at any angle. The recommended position is to install with stem vertical in the upward position. If stem is down, the bonnet acts as a pocket for scale and other foreign matter in the line, which may interfere with satisfactory operation of valve. In liquid lines subject to freezing temperatures, the trapped liquid in bonnet may freeze, causing failure. When installed with stem upward, valves in such lines should have drain plugs in the body as a precaution against freezing.

2. For severe throttling service, plug-type globe and angle valves are recommended. Gate valves should never be used for throttling.

3. When installing check valves be sure that disk opens with flow. To insure closing of disk when back flow occurs, position of check valve in line must permit closure of disk by gravity.

4. Before starting up, be sure that complete pipe line, including valves, is free of all scale, sediment, sand, etc.

5. Make free use of pipe hangers and supports. Properly supported lines eliminate pipe strains which may cause failure.

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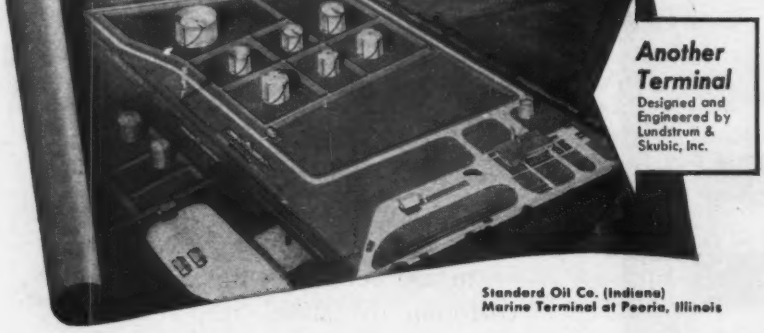

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Cooling-Tower Maintenance

(Continued from page 195)

this type a large number of small nozzles, operating at an extremely low water head, are used. These easily become plugged with small pieces of debris. This type of system is susceptible to increased algae growth, due to the hot water temperature, and to its exposure to direct sunlight. By placing a cover over the distributing system, much of the debris blown in by the wind can be eliminated. This will also retard algae growth, since it shields the water from direct contact with sunlight. If covers are provided for the system, inspection should be made every 2 to 3 months; if not, inspection should be made more often.

The function of the filling is to increase the contact between air and water, primarily by offering new exposed surface to the air as the water cascades through the tower. Another function is to maintain proper distribution of both air and water. Its efficiency is affected by oil, dirt, algae, and other foreign materials, and it is, therefore, important that the filling be kept clean. A filling composed of flat horizontal slats is more subject to the collection of foreign matter than are decks composed of vertical or sloping slats. Sagging filling tends to concentrate the water in the areas of the low spots of the fill. This in turn causes air channeling since the air will not as readily pass through areas of high water concentration as through areas of low water concentration. This air channeling reduces the contact between air and water, thereby reducing the performance.

There are a number of different types of filling used. In general, they fall into two classes: the grid type and the slotted-lath type. The grid type consists of boards or battons nailed upon cleats to form panels. These panels or grids are usually substantial enough to function as scaffolding during the period of erection, and are convenient to walk upon when cleaning and inspecting the tower. The grids are easily removed and are substantial enough to be cleaned with a fire hose.

The slotted-lath type of fill consists of slotted lath, through which are threaded other lath. This type of filling is not nailed and should not be walked upon. It also cannot be readily removed nor should it be cleaned with a fire hose.

The presence of oil in the cooling tower water is detrimental to tower performance. This is because the oil-soaked filling will not be wetted by the water. This results in improper breakup of the water and a reduction in the wetted surface exposed to the airstream. Oil deposits have been removed from the filling by means of solvents and steam. However, it is usually cheaper to replace the filling.

Algae growth probably contributes more to reduce the performance of cooling towers than any other factor. Once algae has made headway there is very little to do but to shut down the tower and do a thorough cleaning job. This is usually accomplished by means of a fire hose and/or circulating a strong chemical solution. This should be followed immediately by a flushing and draining of the entire cooling system to prevent fouling of heat exchange surface of the dead algae.

Cooling-tower basins are usually constructed of concrete; however, they are also made of redwood and steel.

Occasionally one will find that the water circulated in the tower will have a detrimental effect on the concrete basin; in such cases, it has helped to plaster the basin with an asphaltic base material similar to roof putty.

When cooling-tower basins are constructed of redwood, it is difficult to maintain a watertight basin. This is particularly true when a tower is used seasonally such as in connection with an air-conditioning system. A redwood basin should never be allowed to dry out, as a change in moisture content of the wood is followed by a change in its dimensions. If redwood is allowed to dry and shrink, and then to soak and swell, it will be

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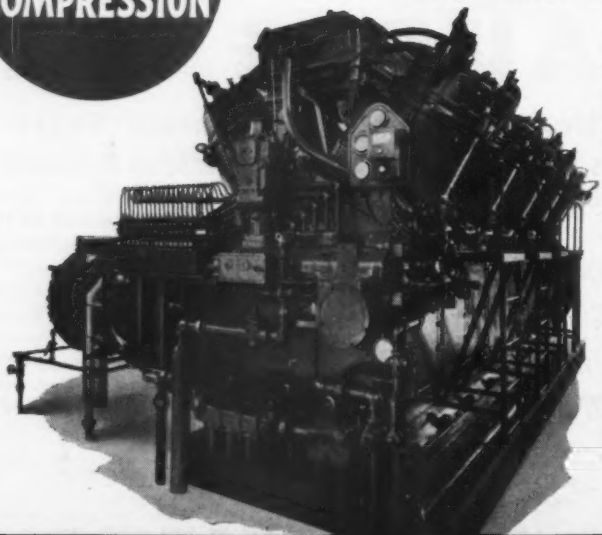

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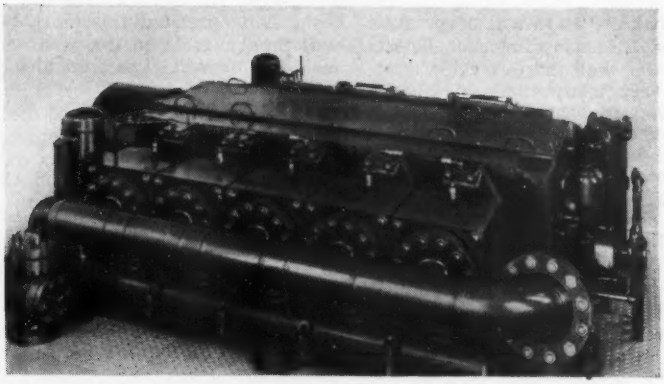

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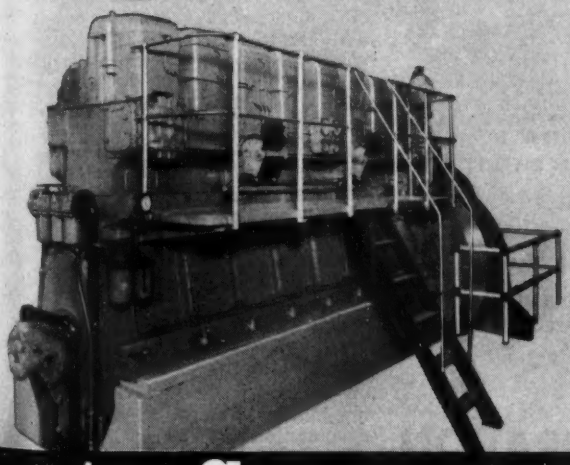

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found that the wood will never quite revert to its former dimension. Therefore, if this wet and dry cycle is repeated very many times, it will be found that the basin will no longer be watertight. This also applies to redwood stave pipe, which is often used as a primary distributing header and should not be allowed to dry out. Also, the reinforcing bands should be kept tight at all times to prevent leakage.

One of the best ways of stopping a redwood basin from dripping is to add shredded asbestos, similar to the fibrous insulating material used in plastering fractionating columns, to the area of the basin containing the leak. This shredded fibrous material will then migrate to the area of the leak and it will flow into and seal the crevice.

Suction-pit screens should be incorporated in all cooling-tower basins. They strain extraneous matter out of the cooling system, and do much to reduce the maintenance of the circulatory system.

An attempt should always be made to keep the water depth in the basin above the level of the anchor bolts, and anchor castings. The interfacial surface between the air and water has been found to be very corrosive. Inspection shows accelerated corrosion to occur at the water line when very little, if any, occurs above and below this point.

Mechanical Equipment

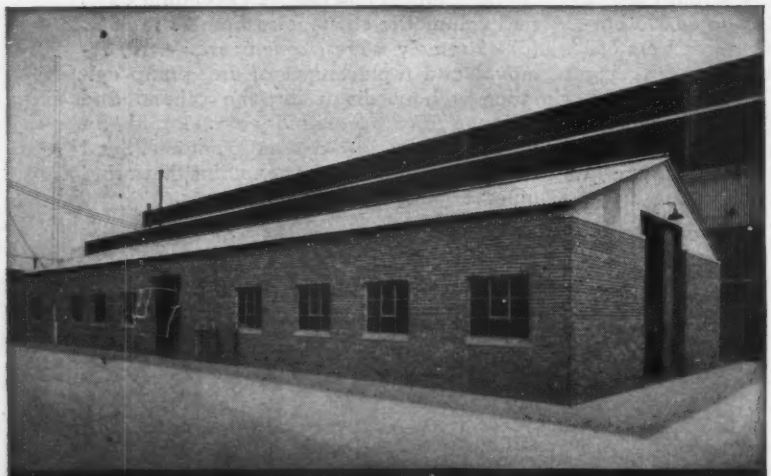
Because failure of any part of the mechanical equipment (such as the fan, gears, or flexible coupling and floating shaft) will shut down the unit, it is important that a regular inspection and maintenance program be adopted. Here is a minimum service schedule for the various pieces of apparatus.

The oil level in the gear housing should be checked every 30 days. If it is found that the level has gone down, the gear case and oil seals should be checked for leaks, and appropriate steps taken to correct them. If, on the other hand, the oil level appears to have risen, drain a 1-qt. sample from the bottom of the housing and check for emulsification and contamination. Because the gear on an induced draft tower is located in a hot, humid air stream, condensation of moisture may occur in the gear housing. This is particularly true in towers which are operated intermittently. Should there be any signs of emulsification, the oil should be removed and replaced with the type of lubricant recommended by the manufacturer. Also, an inspection should be made of the oil seals, particularly the oil seal on the slow-speed shaft. Since oil seals are normally inserted in a small recess in the housing, it collects the moisture condensed on the fan shaft. Any failure of the seal, or corrosion on the shaft at this point, will permit the collected water to enter the unit.

An oil sample should be drained from the bottom of the gear case every 3 months. Again, if the oil shows any sign of emulsification, contamination, or deterioration, it should be drained and the case refilled. The oil should be renewed every 6 months with the exact type of lubricant recommended by the equipment manufacturer.

Once a year oil seals on the gear should be examined and replaced if necessary. Also, bearings should be checked for play, particularly the bearings on the fan shaft where the greatest wear usually occurs. This can easily be checked by rocking the fan blade up and down. If any appreciable wear is indicated, the bearings should be either adjusted or replaced. Where oil is found to be emulsified in the gear unit, indication of excessive wear will usually be found on the lower slow-speed shaft bearing. This is because on some reducer designs sufficient sump capacity for collecting water and sludge is not provided below the lower main bearing. If this condition exists, some relief can be obtained by substituting a large capped reducing nipple for the drain plug in the center of the gear case, thus allowing room below the bearing for the water to settle.

The floating-shaft couplings used



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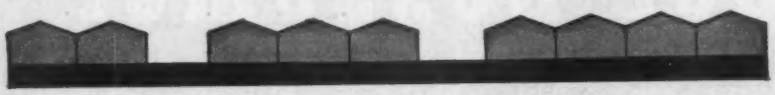

on cooling towers fall into three classes; gear types; metal, fabric, or rubber-disk type, and the universal-joint type.

The gear-type coupling should be taken apart and inspected once a year. The lubricant, together with any contaminates, should be drained and discarded. The teeth on the coupling should be washed with kerosine and examined for wear before reassembling. Care should be taken in the choice of a lubricant for this type of coupling since it operates in a hot, humid air stream and there is danger of moisture condensing inside. As moisture condenses, the centrifugal action of the revolving coupling causes the water to displace the lubricant in the periphery of the housing. Since the gear teeth are also located on the housing periphery, serious wear may occur because of lack of lubrication. Because of this it is recommended that the lubricant used be of the waterproof type which has a specific gravity greater than that of water.

The disk-type coupling should be examined every 6 months for cracks and breaks in the fabric or metal disks. Should they show any signs of wear, the disks should be replaced immediately. It is recommended for all couplings that heavy iron guards be made for each end of the floating shaft to confine the shaft should the couplings fail. This is done to prevent the loose end of the shaft from whipping around and damaging the fan, as well as the motor and gear shafts.

The universal-joint-type coupling should be lubricated every 3 to 4 weeks. This type of coupling requires a heavy oil rather than a grease. Properly lubricated, this coupling will give by far the best service of any of the others previously mentioned since its greater flexibility better adapts it for use on structures which are not rigid.

The gear and motor should be checked for proper alignment once a year. The following procedure for aligning floating shaft couplings is recommended:

The floating shaft and couplings should be removed, leaving a flanged hub on both the motor and gear shaft. Stretch a fine copper wire or chalk line over the top of both the motor and gear flange. Next, check with a square against the flange face and wire or line, first on one coupling and then the other. The square will show any misalignment. This should be done both with the wire or chalk line on top of the coupling and on the side of the coupling. Shifting of the motor and gear and shimming will make one edge of the square parallel with the wire in both positions. When this is accomplished, the unit will be in proper alignment.

The fan blades used on cooling towers fall into three classes: (1) fabricated carbon or stainless steel, (2) cast aluminum, or (3) airplane-wing-section type.

Once a year the fan-blade arms should be examined for fatigue cracks; this applies to all classes of fans. The fabricated stainless steel fan should require little or no maintenance while the carbon steel and aluminum fan blades may be scraped and coated each year or two with a preserving material. On the other hand, carbon steel and aluminum fass have been known to give 5 to 10 years of service with no maintenance work on the blades whatsoever.

A fan will become sufficiently unbalanced in normal service to require rebalancing every 3 to 5 years. This occurs because of the uneven erosion, corrosion, or deposition on the blades over a period of years. Very often, vibration on top of a cooling tower will be blamed upon the fan, when in reality it is due to misalignment of the gear and motor. These two vibration sources can be readily distinguished. The vibration caused by an unbalanced fan will give a swaying motion to the tower because of its relatively great mass and slow speed, while the misalignment of the motors and gears will cause a high-speed vibration which makes a rapping sound.

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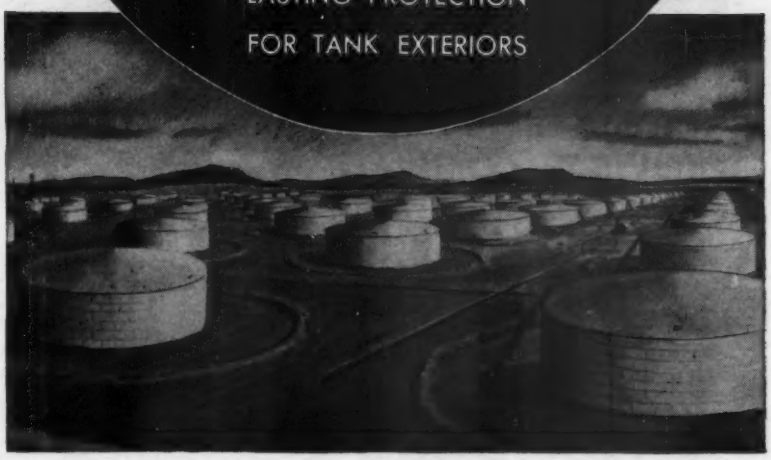

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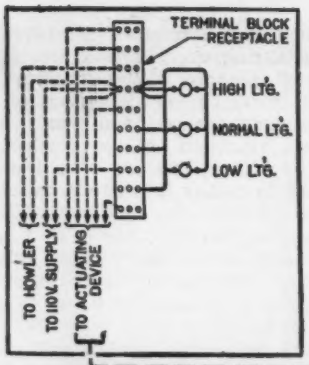

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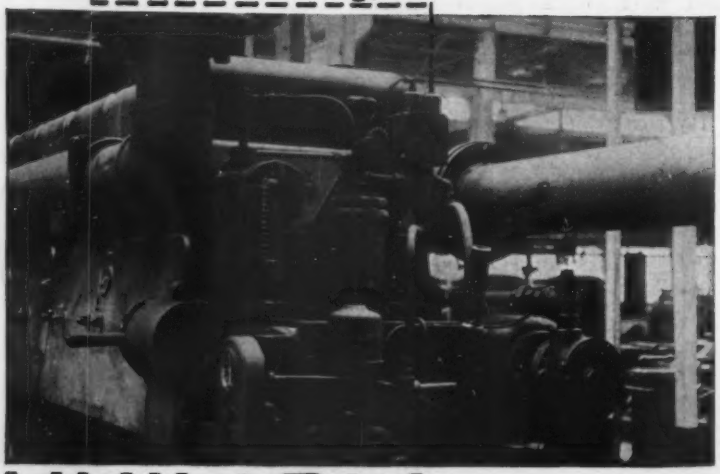

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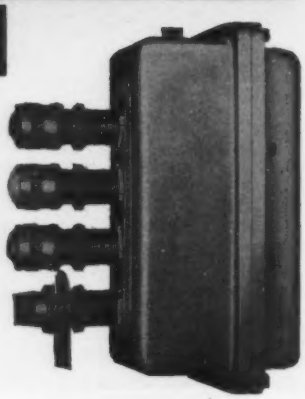

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Maintenance and Repair Of Steam Boilers

(Continued from page 201)

boiler capacity resulted when these high-pressure drops occurred.

Inspection showed that the major portion of the restrictions in the economizers were in the top or hottest section. Mechanical cleaning of the tubes was unsatisfactory because the tube cleaners could not be made to clean around the return bends of the hair pin tubes. Acid cleaning by Dowell was tried on one economizer and, because of the results obtained on this boiler, all economizers were acid washed. Pressure drops were measured across the economizers after the acid wash and also as the run progressed.

A rapid buildup of deposits was noted but it was thought that these deposits were sludge like and became firm only after a long period of operation. Consequently at each boiler shutdown, the economizers were flushed by pumping as much boiler feed water as possible through the economizers and into the boilers before the boilers were fired. Each wash consists of three successive flushes of 5 minutes each. By measurement it was found that the flushing operation materially reduced the pressure drop that had been built up during a run.

Fig. 2 illustrates a typical set of pressure-drop conditions before and after acid washing, during a run and after flushing. Out of eight economizers all have been acid washed once and three twice in a period of 3½ years.

Slagging of brickwork and tubes is another factor in boiler and furnace maintenance. All of the boilers at Whiting refinery which burn coal are equipped with unit pulverizers. Half of these boilers also burn acid sludge. Severe slagging conditions were encountered. The areas most affected were the water-wall risers across the furnace, the boiler tubes closest to the burners and the rear water walls. Water lancing of the slag was tried and found to be very successful where the water stream could reach the slagged areas.

A jet was designed and installed on the end of the lances the use of which allowed the water stream to reach all affected parts of the boiler and furnace. Additional access doors had to be installed on the boilers to accomplish this action.

Fig. 3 shows a section of the jet that is used on a ¾-in. lance with water at a pressure of about 50 psig. Other aids in slag control were careful control of excess air for combustion, an improvement in the quality of the coal purchased, and an improvement in the quality of the acid sludge re-

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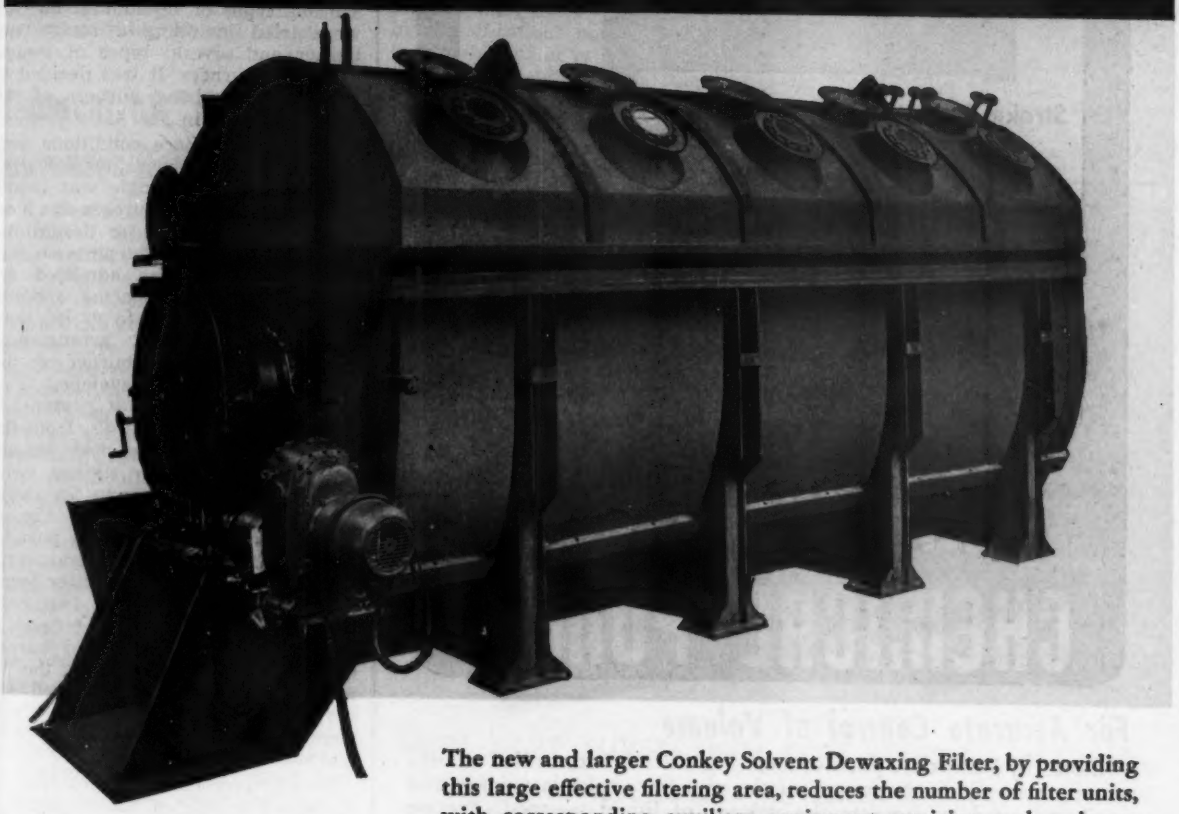

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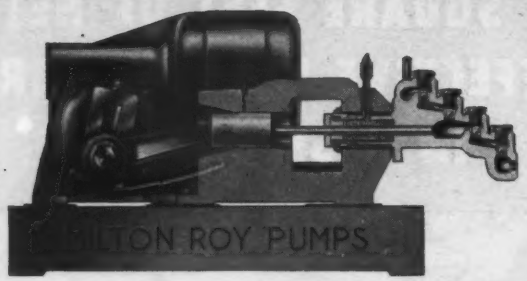
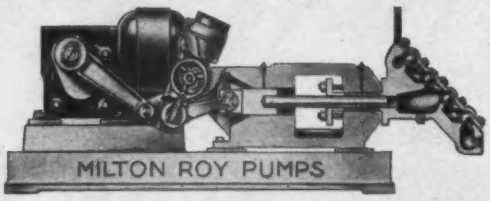


Stroke Adjustment—Screw. Liquid End—Alloy.



Stroke Adjustment—Micro while running.
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ceived for burning. Before these changes were made, three or four shifts of deslagging were necessary at each shutdown. Since the changes were made, one shift is all that is required to deslag a furnace.

Refinery acid sludge and/or heavy fuel oil are burned on the liquid-fuel burners at one of the power stations. The heat release from each burner is about 75,000,000 B.t.u. per hour. There are four burners per boiler. Various types of liquid fuel burners were tried including a rotary cup burner and several types of steam-atomizing burners. It was decided to use steam-atomizing burners of the type illustrated in Fig. 4.

To fit the furnace conditions, exit angles of the burners were varied until the optimum angle was found. In developing these burners the most dificult problem was to design the throats and steam inlet ports so that sufficient steam was admitted for atomization. Angles, spacing, and size of the steam ports were varied until the throat and port arrangement as illustrated by the burner on the right of Fig. 4 was developed. This is the burner in use at present. It has 12 exit openings at 35° from the axis of the burner. The openings are ¼-in. holes. There are sixteen ⅛-in. holes in two circular rows for steam ports, spaced as shown in Fig. 4. The steam ports are drilled parallel to and 1/16 in. from the transverse center line. The left and center burners shown in Fig. 4 show two steps in the development of the burner. It will be noted that the final burner is more easily machined than the intermediate ones. Steel is used for burners in fuel-oil service only and Monel is used for burners which burn fuel oil and/or acid sludge.

Severe corrosion is experienced on the flue-gas side of the economizer tubes. The economizers consist of 21 hairpin tubes per row, 20 rows high. The water enters the bottom row at about 220° F. and leaves at the top at about 330° F., while the flue gas enters at the top and leaves at the bottom. External corrosion occurs only on the tubes near the bottom portion of the economizers, where the tube-skin temperatures are below the dew point of the flue gases.

Fig. 5 shows typical economizer-tube corrosion at the station under discussion. Corrosive action takes place while the unit is in operation. To prevent attack from flue-dust deposits during shutdown periods, the economizers are washed with water externally after the boiler passes are blown. The induced draft fan then draws air, which has been heated by the furnace and boiler sections, across the economizer thus thoroughly drying the tubes. No practical remedy has been found to date to stop the corrosion which takes place during operation. However, it is felt that an improvement has been accomplished by purchase of a higher-quality coal

and by better conditioning of the acid sludge by the refinery.

During scheduled shutdowns, tubes in the lower sections of the economizers, which were questionable due to their age, are replaced even though they have not failed. This action was taken with the view of preventing emergency shutdowns, especially during the periods when the maximum steam-generating capacities were demanded. Similar corrosion is found in the air preheaters even on boilers burning only fuel oil and fuel gas.

Removal of "Bottleneck" Increases Refinery Output

(Continued from page 202)

number of other projects currently being studied have as their object the recovery of valuable fuel components.

Immediate increases in refinery production have been realized from a comprehensive survey of plant losses leading to suggestions for loss reduction. Again, increasing realizations have permitted the justification of investments not previously considered to be worthwhile. Evaporation losses are being reduced by an active tank-repair program. A review of flare losses produced practical suggestions for their reduction. Losses from separators have been reduced by the installation of separator inlet skimming devices.

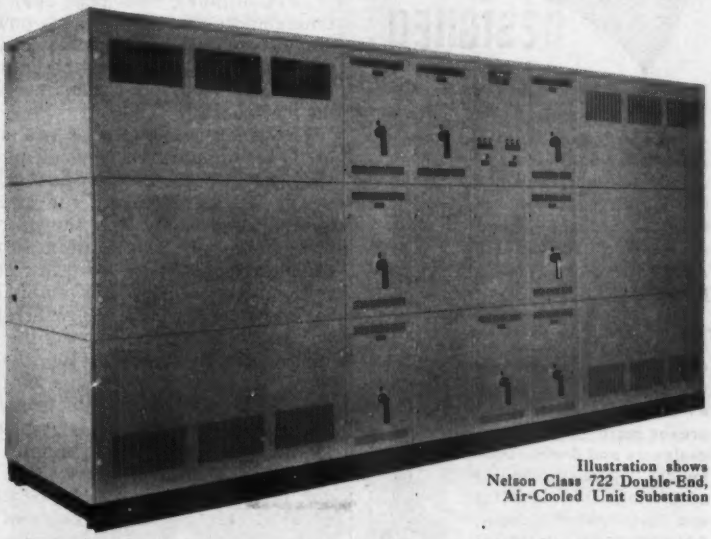
Increase to Pipe Stills

A major function of the program has been to increase the capacity of processing units with essentially no equipment additions. This has been accomplished by an extensive test program utilizing improved instrumentation and controls. The outstanding accomplishment in this category has been a 20 per cent increase in the crude throughput to six two-stage pipe stills. Chemical treatment for corrosion control and the use of pH recorders have resulted in improved service factors and decreased maintenance costs. An extensive program of cooling-water chlorination has resulted in substantial improvements in heat transfer.

Complementing efforts to gain capacity by better utilization of existing equipment have been projects to determine unit limitations or bottlenecks and to effect their removal. The importance of well-directed test work in this regard cannot be overemphasized. By this means the limitations to increased capacity at a large crude distillation unit were demonstrated to be preheat, pressure drop through exchangers, water entrainment in a reflux stream, and inadequate pumping capacity. The requirements to overcome these limitations were clearly shown by the test program and their elimination is now under way. Test work at catalytic cracking units proved the limitations to be preheat and regeneration capacity. In the latter instance a project to install previously idle air compressors to provide more regeneration capacity is nearing completion.

A number of improvements from the standpoint of better equipment utilization and reduced losses will result from a review of intrarefinery movement of stocks. The necessity for rerunning stocks to permit meeting specifications and to circumvent the limitations of primary distillation equipment results in less than optimum utilization of lines, pumps, tankage, and distillation equipment. A survey was made of all rerunning operations and many possible improvements were immediately recognized. This program was so successful that it was possible to release a 10,000-bbl. shell-still system for crude-distillation service.

Contributing to this improvement were segregation of stocks, closer control of distillation operations and the use of extraneous reflux technique. This involves replacing normal bubble-tower reflux with a stock of similar boiling range which requires rerunning or splitting. A schematic diagram on one installation is shown in Fig. 1. The advantages of this technique are that it affords an opportunity to rerun stocks with little expense and releases capacity on



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other units. This operation has permitted the needed change in "explosivity correction" of its specifications of nearly 4,000 bbl. per day of a residual-fuel component with no new equipment requirements.

The latent capacity of many pieces of existing refinery equipment has been demonstrated by this program. Ultimately, improvements in throughput and performance may obviate the need for the construction of new equipment.

Lion Oil Fire Prevention Establishes Record

(Continued from page 209)

emergencies before the dry-powder single-type foam generators can be set up for use. Numerous other items of miscellaneous equipment are kept on the trucks.

Fire-truck water pumps are operated 15 minutes each week unless they have been in use during that week. Truck motors are run at least 5 minutes per day and the gasoline and oil supply are examined after each test run. To insure quick starting a battery charger is maintained for use on truck batteries, which may be charged without removing the batteries from the trucks.

Chemical Extinguishers

Extinguishers of the dry-powder foam type are used extensively around the refinery. Seventy-five 2½-gal. foam extinguishers are distributed at strategic points throughout the refinery. These units are mounted on brackets about 3 ft. off the ground to facilitate handling.

Sixteen 40-gal. foam extinguishers, mounted on wheels, are located on all street corners throughout the plant.

Four 2,500-g.p.m. dry-powder single-type foam generators are included with other equipment carried on the trucks.

In order to assure that all extinguishers in the refinery are operable, a card-file system is maintained showing the location, installation date, date charged, location of fire, name of user, and other remarks. All extinguishers are checked each day to see that they are on location and in proper operating conditions.

All foam extinguishers which have not been used during a 12-month period are returned to the fire-department repair shop, where they are tested at 200-psi. hydrostatic pressure for leaking gaskets, defective valves, hose, or thin containers. A stock of valves, hose connections, and other parts is maintained for repairing extinguishers. After all repairs are made, the extinguishers are given a new coat of paint, recharged, and placed on location for further use.

In connection with foam-type extinguishers, it may be well to explain that all foam powder must be stored in a dry place and the containers turned every 90 days to avoid packing and lump formation.

Carbon-Dioxide Extinguishers

In addition to a daily inspection of all extinguishers, the CO_2 extinguishers are weight checked each week by means of hand scales to determine any loss of CO_2 by use or leakage. If the net weight loss exceeds 6 per cent, the bottle is returned to the shop for recharging.

The bottle to be recharged is placed on a steel rack which is mounted on platform scales. After allowance is made for dead weight, enough CO_2 is bled from the bottle to cool it; then by means of a flexible hose, CO_2 under pressure is charged into the bottle. The control valve of the recharged bottle is then oiled and the extinguisher is ready to be replaced on the location from which is came.

Fire Hose

The Lion fire department has in stock 4,000 ft. of 2½-in. National Standard fire hose, 1,500 ft. of which is rubber covered for use in areas where acids exist. The remaining 2,500 ft. is double-jacketed fiber hose for general use. An extra 1,000 ft. of this fiber-jacketed hose is carried as spare stock. Also, approximately 1,000 ft. of 1½-in. National Standard rubber hose is stocked for small line service and yard maintenance.

Irrespective of the service period, all fire hose is pressure tested at 200 psi. every 90 days. The hose sections are connected to the pumping unit mounted on the fire-truck bumper. Test water is obtained from a convenient fire plug and water pressure is applied to the hose and nozzle under test. Any fire-hose section that is condemned by test for further fire service may be repaired for yard service. Sections of hose over 40 ft. in length that test satisfactorily may be recoupled in the shop and placed back in fire service. Any damaged coupling, needless to say, is also replaced by expanding the new coupling onto the hose section. The expanding tool and hydrostatic test pump are mounted on a steel work bench and are conveniently arranged for ease of operation. After being used, all fire hose is cleaned of any adhering residue and scrubbed before drying and placing it in storage. A movable rack mounted on casters and provided with a special hose-winding mechanism affords an easy method of winding and storage. By such a storage procedure, it is possible to protect the hose from the weather as well as sharp bending, both of which are detrimental to long hose life.

Water System

Lion's water system makes a com-

plete circuit around the plant area. Fire hydrants are located at all street corners and at other necessary points. Pressure is maintained on this system at all times; also, a booster pump is manifolded into the fire line that can be used in cases of emergency to give increased pressure when needed.

In order to assure proper working conditions, the booster pump is tested once each month for lubrication, condition of packing, and ability to maintain pressure. All fire hydrants are flushed out once each month and the stuffing boxes are kept well oiled. Enough spare hydrants are kept in stock to replace any that may need extensive repairs.

The maintenance of fire-fighting equipment requires constant vigilance on the part of the personnel of a refinery fire department. This group of selected men is guided in their work by a realization of their responsibility to the management and their fellow workers. To this end all efforts are exerted to inspect and maintain all fire-fighting equipment so that fire risks may be eliminated and the fire equipment will be kept in the best possible condition at all times.

Safety at Wood River Sold to Workers

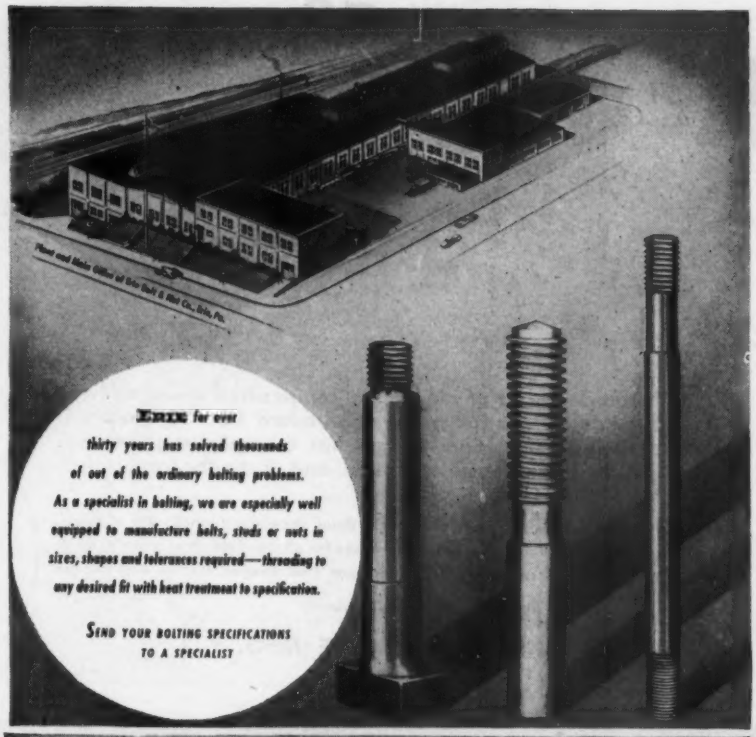
(Continued from page 206)

all other meetings, suggestions from the men themselves.

It will be seen from the foregoing that every employe participates in the program, has a voice in it, and understands it.

The safety-department personnel function to a large degree on a zone basis. One inspector is assigned to each of the five zones into which the refinery is divided and is responsible for all safety procedures within that zone. He conducts meetings, inspects, and keeps in operating condition all fire and safety equipment in his area. It is his duty to post bulletin boards and "days worked" boards, make suggestions to the department managers in his zone, improve safe working conditions, and issue fire and safety permits in his zone.

Because of unusual hazards such as toxic gases and acute danger of fire present in a refinery but not generally found in most other industrial plants, the fire and safety department is required to make an inspection to assure that all necessary precautions are taken and then issues permits to all crafts prior to the use of any burning equipment and before entering any vessel. Since these permits amount to 1,500 to 2,000 per month, the zone safety inspector cannot handle all of the volume and the, sixth inspector is "on call" for this purpose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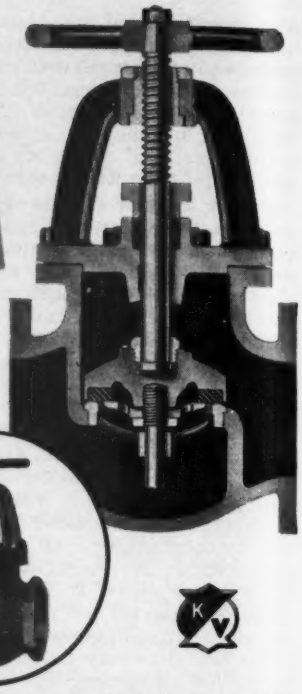

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throughout the refinery. Craftsmen call in on a telephone used only for this purpose and the "call" inspector drives by automobile to the area and takes care of the permit. Prompt service of this type discourages any chance taking..

By rotating from one zone to another every 2 months, these six inspectors keep informed on all operations in the refinery, avoid going stale, and broaden their general knowledge and experience.

Two other inspectors spend their full time in fire-prevention activities. One maintains all fire equipment and instructs fire crews throughout the plant. (Fire crews are used in preference to a single paid department). These fire crews are made up of operating employes in the various zones who are familiar with the hazards in their area and have proved highly satisfactory and capable.

One inspector devotes his full time to fire training. This is a continuous job with a great deal of followup. Neither he nor the fire equipment men rotate as do the other inspectors since they operate on a refinery-wide basis. Also, although two men are specialists in fire fighting, all of the inspectors are trained fire fighters.

BOOKS

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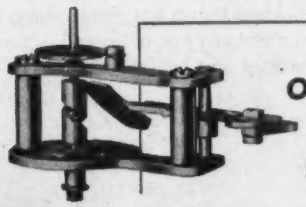

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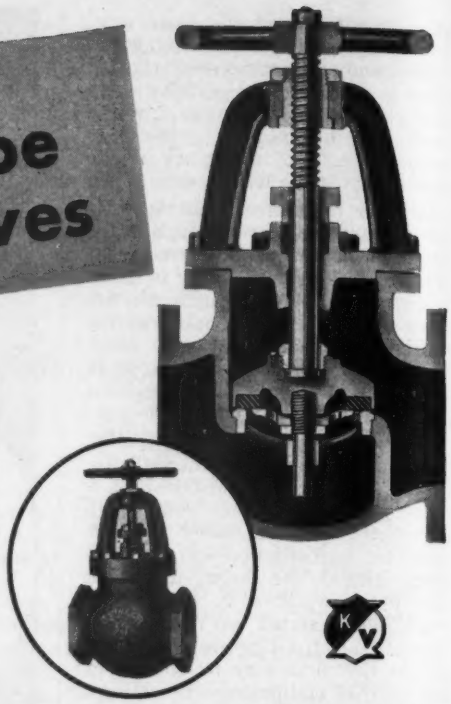

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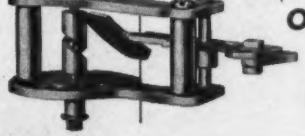

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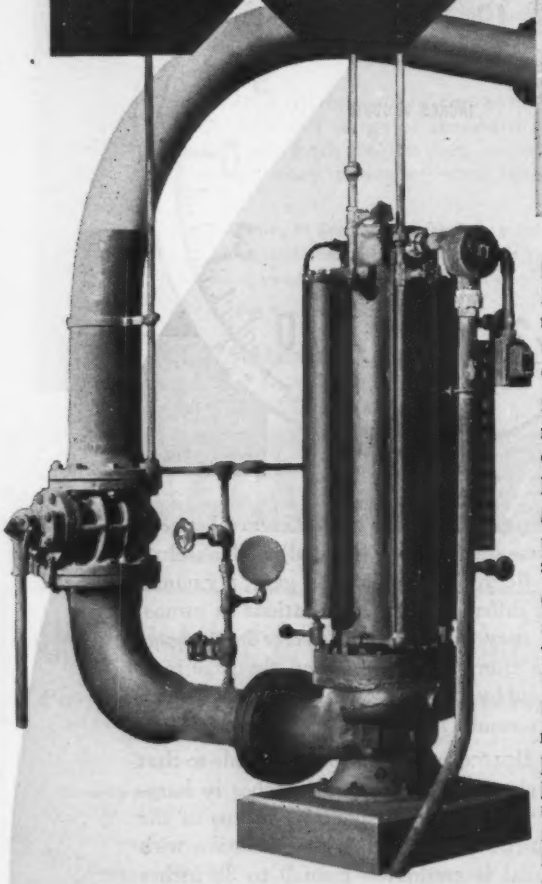
of pumped liquid to atmosphere because of the seal oil system



BJ Process Type Stuffingboxless Pump, installed at Union Oil Company's Wilmington Refinery. Size: 4 x 6 x 10LL. Pumps Iso-Butane at 130° F.; 450 gpm against a 450 foot head. Several hundred BJ Stuffingboxless Pumps are in service.

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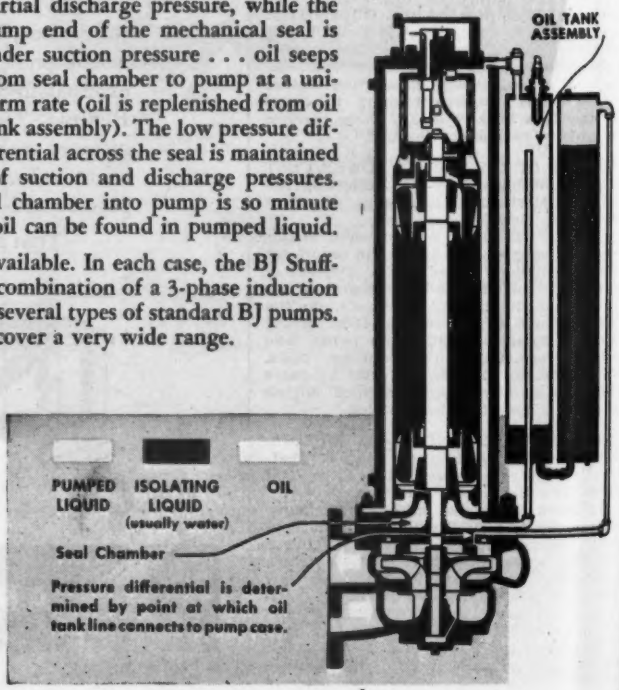
Mechanical Seal. A double mechanical seal, contained in an oil-filled seal chamber, replaces the stuffingbox.

Oil Tank Assembly. A two-compartment oil tank assembly holds the auxiliary motor oil supply and provides a method by which partial discharge pressure is transmitted to motor oil and seal chamber.

Fixed Pressure Differential Across Seal. Since the motor and seal chamber is under partial discharge pressure, while the pump end of the mechanical seal is under suction pressure . . . oil seeps from seal chamber to pump at a uniform rate (oil is replenished from oil tank assembly). The low pressure differential across the seal is maintained *constant,* regardless of suction and discharge pressures. Oil seepage from seal chamber into pump is so minute that no trace of seal oil can be found in pumped liquid.

Several Types are available. In each case, the BJ Stuffingboxless Pump is a combination of a 3-phase induction motor and any one of several types of standard BJ pumps. Capacities and heads cover a very wide range.



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Left: Catalyst column, 3 ft. i.d. by 25 ft. long, fabricated from 10 per cent Lukens nickel-clad steel, with cladding on inside

A 66-in. i.d. elliptical dished head, 3 23/32 in. thick, the thickest ever formed of nickel-clad steel by Lukens

CLAD STEELS *Reduce* CORROSION

—*Enabling Greater Economy in Refineries*

by W. G. Theisinger*

DEVELOPMENT of **clad** steels was to obtain economical thickness of corrosion-resistant metals (compared with solid similar material) for unfired pressure vessels as fractionating towers for crude oil in distillates from catalytic cracking plant; shells and tube sheets of heat exchangers, and condensers, separators, flash and coke chambers. The goal was to contribute lower finished-material costs without sacrifice of structural strength.

The most important clad metals are covered in the following list:

1. Nonferrous: Nickel, Inconel, Monel, copper.
2. Straight chromium steels: (11.50 to 18 per cent chromium).
3. Chromium nickel steels: (16.0 to 26.0 per cent chromium and 6.0 to 22.0 per cent nickel. Titanium, columbium, and molybdenum may also be present).

Clad steels are used extensively in petroleum refining. They are essential because of three conditions under which raw materials are converted into finished products:

1. Some raw materials, both crude oil and natural gas, are corrosive because they contain acidic sulfur or chloride compounds.
2. In others, cracking operations increase such acidic corrosive compounds as hydrogen sulfide.
3. Processing operations such as acid polymerization and alkylation are very corrosive to refinery equipment.

Refining employs two methods of combating corrosion. One is to neutralize the corrosive acids with alkalies or ammonia, and the other is the use of clad steels or alloy-lined towers. Clad steels installed in new equipment eliminate out-of-pocket expense for chemicals, have certain advantages, and are more permanent than alloy liners in pressure or vacuum towers.

Need for Corrosion-Resistant Metals

Need for corrosion-resisting metals is indicated by the corrosive nature of the chemicals essential to refining, either as products or processes or as treating and catalytic agents.

Heat and pressure are in part responsible for converting otherwise noncorrosive materials into corrosive ones. Cracking, with its attendant higher temperatures and higher pressures, is often the cause of corrosive compounds.

Cracked distillates are more difficult to treat than those from straight-run distillates. They require more extensive use of chemicals or adoption of the more recent catalytic treating processes. In each instance clad steels are recommended. Regenerator towers using caustic soda-methanol are quite corrosive to carbon steel and operate considerably longer with lower maintenance cost, when clad steels are used in the reboiler sections. For instance, two types of hydrocarbons which naturally have no inclination to combine units readily in the presence of 98 per cent concentration of sulfuric acid. This is the basis of catalytic alkylation, source of part of several materials which are blended to make 100-octane aviation gasoline.

A phase of these processes is the recovery and regeneration of the catalyst, which adds to the necessity of clad steels to resist corrosion.

Identities of many catalysts are not generally made public or cannot be stated at this time, hence types of clad-steel requirements are known only to the catalyst users. It is significant, however, that pressures range from 50 to 3,500 psi. and that the temperature variation is from subzero to 1,400° F.

The most important process of sweetening gasoline is the caustic soda-mercaptan removal operation.

Although there is a trend toward catalytic treating, most of the finished materials from refining plants are

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treated with chemicals, among those used being caustic soda and sodium plumbite. Since these chemicals must be revivified to desired concentrations, clad steels and solid alloys are recommended in service vessels, lines, pump parts, and fittings.

Clad steels as manufactured by Lukens consist of a light layer of corrosion-resistant metal—nickel, stainless, Inconel or Monel—permanently bonded to a heavier backing plate of A.S.M.E. specification steel, to provide economically both resistance to corrosion and protection against iron contamination.

Clad-steel plates make possible the economical construction of large or heavy processing, storing, and transporting equipment that will operate satisfactorily even under pressure, vacuum, heat, or cold.

Clad steels are normally furnished with the clad thickness equal to 10 per cent of the total plate thickness. However, the clad thickness may be varied to suit operating or fabricating conditions—from 5 to 50 per cent—to provide the same protection as nickel, stainless, Inconel, and Monel at a substantial reduction from the cost of solid corrosion-resistant metal.

Clad steels are produced by hot rolling. The precision method of assembly and the heavy, uniform pressure employed to bond and reduce the components insure uniform cladding thickness in the finished clad plate.

The backing plate may be any carbon or low-alloy steel of standard plate specification. High strength or other properties required in the backing may be obtained from special low-alloy steels. The bond or adhesion strength of Lukens clad steels is formed by plastic working at high temperature on one of Lukens rolling mills. The use of nickel plating on all cladding materials containing chromium assures a permanent bond.

The quenching in water of stainless-clad steel plates with high coefficients of linear expansion from a temperature of 1,800° F. revealed no evidence of bond failure after 20 cycles of heating and quenching. To approximate conditions encountered in fractionating towers, coking drums, and other similar equipment commonly subjected to extreme thermal shock, samples of 20 per cent types of 347 and 410 clad, ½ in. thick, were heated to 1,000° F., and water quenched to room temperature. This cycle was repeated 350 times with standard A.S.M.E. shear tests made at intermediate points. The results indicate that the shear strength is not affected and is at least double that of the minimum requirement of A.S.M.E. Boiler Code specification of 20,000 psi.

Nickel-clad steel is used by the petroleum industry for pressure vessels, tube sheets, and storage tanks for caustic soda solutions.

Stainless-clad steels are used for a wide variety of petroleum equipment in applications where stainless is particularly resistant to corrosive attack. Whereas sea water is not usually a suitable application for stainless-clad, the other clad steels are frequently used in sea water applications.

Inconel-clad steel has been used in the petroleum industry in condensers, heat exchangers, and other elevated-temperature equipment handling hydrochloric acid.

Monel-clad steel is used to withstand corrosive acids in the top sections of fractionating towers in the hydrofluoric acid alkylation process.

Mechanical properties of nickel-clad, stainless-clad, Inconel-clad, and Monel-clad steels, as determined by tensile tests, are equal to or better than the strength of the steel usually used for backing, such as A-285 Grade C.

Clad steels are high in heat conductivity; stainless-clad plates have higher thermal conductivity than solid stainless of the same thickness.

The design of clad-steel equipment follows closely general practice for design of similar steel structures.

The economic design of equipment is aided by the availability of wide plates and large heads which may be obtained in Lukens clad steels.

In all applications involving clad-steel plates, the widest plate available can always be employed with resulting saving in fabrication costs.

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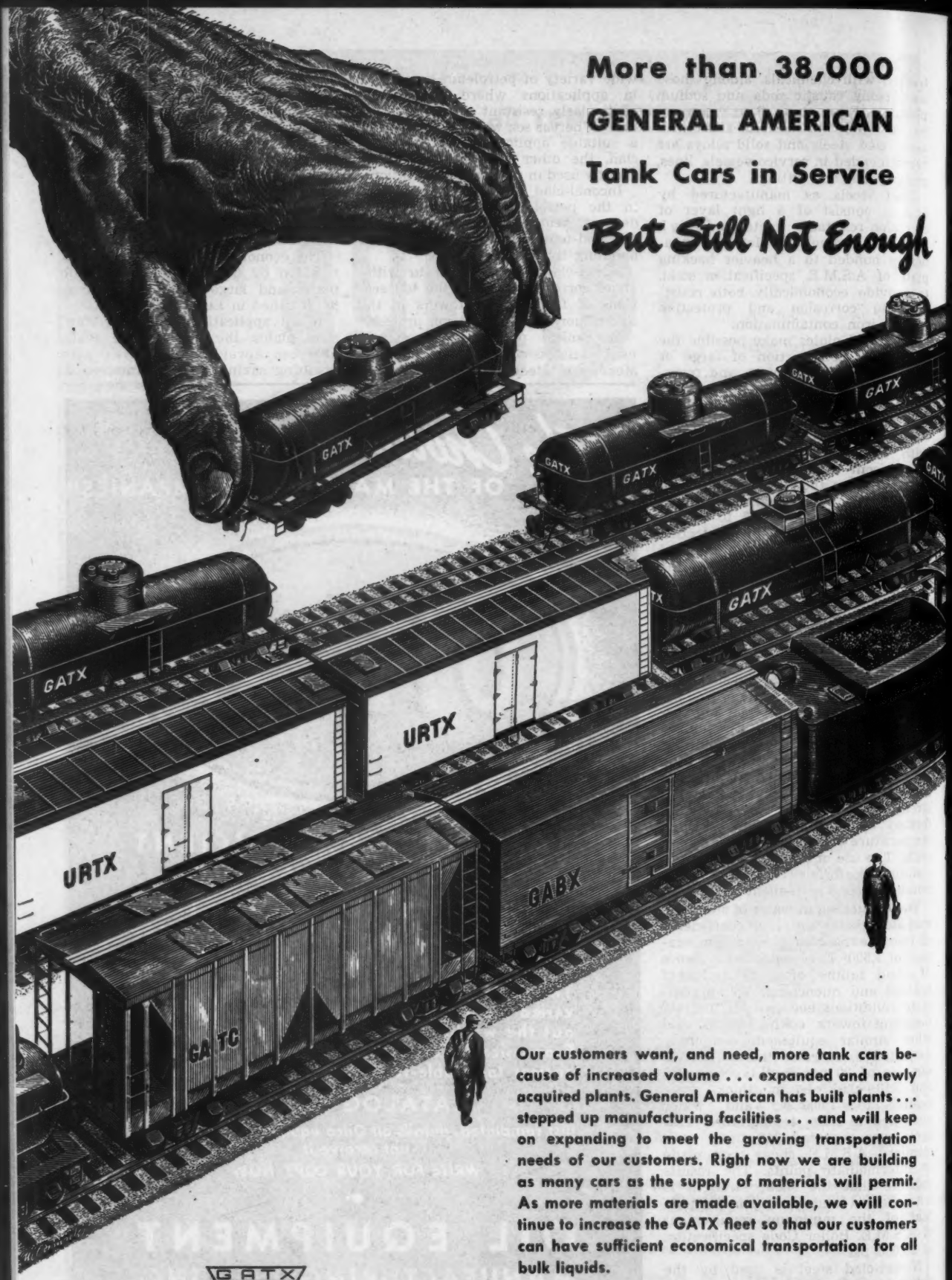

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PROGRESS IN METALS

by W. L. Nelson

Consulting Engineer

High Chromium Nickel Alloys

Essential in Dehydrogenation of Butane and in Butadiene Processes

THE huge superheated steam generating units required in butadiene plants require the use of high-chromium nickel alloys in raising the steam temperature to 1,400° F. The steam-generating equipment of the Combustion Engineering Co. of New York employs 18-8 chromium nickel stainless-steel tubes in the outlet section of the superheater, tube supports of 25-12 chromium nickel stainless steel (Type 309), and tube spacer castings of the 310 type (25-20 chromium nickel).

Although high chromium (27 per cent) and high-chromium-nickel iron alloys (27-20) have long been recommended for extreme high-temperature service (1,150°-1,400° F.), valuable practical experience was gained during World War II. These experiences as recorded in studies of Rubber Reserve Corp. (Office of Rubber Reserve, of Reconstruction Finance Corp.) were reported by H. D. Newell, chief metallurgist of Babcock & Wilcox Tube Co., in a news release late in August 1946. The following discussion pertains to the use of 27 per cent chromium iron alloy, used so extensively in butane dehydrogenation units. Service and laboratory tests of this alloy were conducted, under contract, by Babcock & Wilcox Co.

"It was found," Newell said, "that the relative chemical inertness of the 27 per cent alloy under alternate reducing and oxidizing conditions, such as are encountered in the catalytic dehydrogenation of n-butane, warranted the use of this material for equipment for making butadiene."

Up to the present, its use in these processes has been confined primarily to preheater tubes, process piping or liners for such piping, headers, "snake" tubes, and catalyst tubing and fittings in dehydrogenation plants using unit or tubular-type catalyst-case constructions. Some of the alloy also has been used for protection tubes of thermocouples measuring catalyst bed temperatures, for catalyst support screens and plates in vessel reactors, and for sheets or baffles in catalyst vessels to prevent gas infiltration back of the refractory linings.

Sigma Embrittlement

Embrittlement, due to sigma phase precipitation or "885° F. embrittlement" (or both), appears to be the one most deleterious factor that curtails the useful life of this alloy in dehydrogenation plants. Sigma phase is a brittle intermetallic iron-chromium compound which forms in alloys containing more than about 25 cents chromium on long heating in the range from about 950° to 1,250° F. Its precipitation causes increased hardness and drastic loss of ductility.

"An understanding of the characteristics of this alloy, especially its grain growth in welding, lack of transformations during heat treatment, its extreme notch sensitivity, and its tendency to become embrittled within the range of temperatures encountered in the dehydrogenation process, warrant several suggestions in the interest of securing satisfactory service and of minimizing maintenance and breakage."

For welding, he suggested the use of a nickel-bearing austenitic or partially austenitic welding electrode, preheating before welding, stress relieving at 1,300° F. minimum immediately afterwards, followed by rapid cooling.

"Sharp notches and reentrant angles in design or repair should be avoided as well as folds, nicks, scratches or stamping of numbers," Newell said. "Shock stresses ought to be avoided, but if required, should be performed when the metal is at 550° F. or higher. The use of copper gaskets on certain types of flanges and hand-hole fitting seats has helped maintain tight, leakproof joints. Graphite, applied to threads and contact areas of bolted fittings, will reduce galling and sticking.

How to Avoid Embrittlement

"In order to avoid 885° F. embrittlement, cooling after service through the 1,100° to 700° F. range should be relatively rapid. Below 700° F., the cooling should be more moderate. Sigma phase may be removed by heating for not less than 1 hour at a minimum temperature of 1,500° F., and quickly cooled through the range 1,100° to 700° F. so as to avoid the 885° F. embrittlement.

"Regeneration procedures must be controlled at all times to prevent overheating. An excessive temperature would be one that is high enough for carburization of the metal, which probably means temperatures in excess of about 1,700° F. Ordinarily, the maximum temperature reached during normal operations of dehydrogenation should not exceed about 1,350° F. except during heat treatment for sigma phase removal."

Cold Treatment of Metals

TREATMENT of metals by cold at temperatures ranging down to —120° F. is looked upon by many metallurgists as one of the most important developments brought about by the pressure of wartime production in the field of metal working. Cold treatment supplements heat treatment in hardening, stabilizing, and shrinking of metals, and while it has already proved highly valuable in prolonging tool life, in preventing changes in metals through aging, in stepping up shrink-fit operations, and in testing, the development is still considered experimental in the metal industry.

Temperatures as low as —120° F. are maintained with the deep-freeze principle of refrigeration with equipment capable of removing 1,000 B.t.u. per hour when the work is immersed in a convection fluid. This rapid rate of heat absorption gives faster shrinking, testing and treating of metals at a considerable saving.

Cold-treating practice is now finding greatest use as a means of hardening and stabilizing tool and die stocks, gages, studs, etc. Uniformity of hardness is improved and hardness is often increased. Retained austenite is eliminated through the complete transformation of austenite to martensite which occurs during the subzero treatment.

The life of drills, cutters, gears, and like items, is being increased as much as 100 per cent through cold-treating practice, thus allowing longer use between sharpening. Precision instruments and gages, which formerly were aged for several years before use, are now stabilized by cold treating in a matter of hours. Heat and press fit for the assembly of male and female parts has been outmoded by the shrink-fit assembly method made possible through the use of subzero temperatures. Numerous aircraft parts, such as radio receivers and transmitters, oxygen masks, and operating instruments, which may be affected by the extreme cold of high altitudes are being tested by these techniques.

The postwar possibilities of cold treating of metals and other materials used in industry are extremely promising. With wartime pressure relaxed, further research and experimentation in cold treating promises to develop limitless applications in industry.

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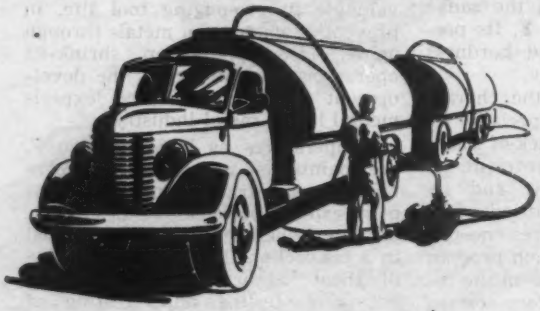

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NATURAL GAS

Ohio Fuel Gas Seeks Increased Capacity

Ohio Fuel Gas Co., Columbus, Ohio, has requested Federal Power Commission authorization to construct facilities to increase the company's natural gas transmission capacity to Marion and Lima, Ohio, markets. Capital cost of the line is estimated at $2,986,250. Construction would begin in May this year with all major construction being completed by December 1, 1948.

Facilities requested include about 97 miles of 20, 16, and 12¾-in. lines extending from Ohio Fuel's Treat compressor station to a connection with the facilities of West Ohio Gas Co. at Lima, Ohio.

Ohio communities that would be served by the proposed line include Ada, Indian Lake, Mount Gilead, Cardington, and Kenton in addition to Marion and Lima.

Northern Natural Tariff Hearing Is Scheduled

The Federal Power Commission has set a hearing to commence March 30, 1948, in Omaha, Neb., to determine the effect that Northern Natural Gas Co.'s proposed modification of its tariff may have on gas service, and to determine whether any changes should be made.

The proposed modifications, copies of which have been served upon each of the gas distributing customers of Northern Natural, would amend the provisions of the section of the tariff concerning delivery to the company's distributor customers of new gas requirements of large volume consumers.

Northern Natural transports natural gas and sells it to distributing companies in Kansas, Nebraska, Iowa, South Dakota, and Minnesota.

Texas April Natural Gas Allowables Set

AUSTIN.—April allowables totaling 1,141,472,597 cu. ft. daily for 22 of Texas' 23 prorated gas fields have been set by the Texas Railroad Commission.

The total represented a slight drop of about 1 per cent, or 15,092,779 cu. ft. daily, from the total for the March allowables. The Carthage field was given an allowable of 606,208,434 cu. ft. daily against 610,213,871 cu. ft. daily for March. The other prorated field, Panhandle, is on a separate schedule.

Allowables in cubic feet daily follow: North McFadden 17,133,000, Alief 7,500,000, Blue Lake 5,166,666, McCoy 3,500,000, Needville 25,000,000, North Louise 5,910,000, Old Ocean 162,810,000, La Blanca 13,993,933, La Sal Vieja 1,666,666, McAllen 17,583,333, Riverside 3,660,000, Rooke 15,263,000, South Waslaco 26,833,333, Carthage 606,208,434, Navarro Crossing 11,342,166, Oakwood 4,355,833, Rodessa 27,402,566, Tri-Cities 20,190,000, Waskom 70,023,767, Whelan 89,123,234, Sipes Springs (high pressure) 1,633,333, and Eden 5,233,333.

1947 Natural-Gas Income Increases 16.1 Per Cent

Operating revenues of natural-gas companies in 1947 totaled $663,378,000, an increase of 16.1 per cent over the $571,145,000 received in 1946, according to a report of the Federal Power Commission.

Natural-gas utilities had an operating income in 1947 of $124,012,000, an increase of 14.7 per cent over the 1946 income. Revenues from residential and commercial service increased 19.7 per cent and 25.0 per cent, respectively, over 1946. Revenues from industrial service were up 11.5 per cent.

Natural Gasoline

McCarthy Cycloversion Unit to Begin Operations

HOUSTON.—The cycloversion unit being added to the 85,000,000-cu. ft. daily natural-gasoline plant operated by the McCarthy interests at Winnie, Jefferson County, Texas, is expected to go into operation April 1.

The equipment, a Perco catalytic reforming unit, will operate on naphthas and similar fractions. The plant is a property of Absorption Plant, Inc., which is controlled by McCarthy Oil & Gas Corp., Houston.

Unit 1 of the new chemical plant being built adjacent to the gasoline plant by McCarthy Chemical Co. is scheduled to be completed about May 1. This unit, which will produce formaldehyde, methanol, and acetaldehyde from natural gas and other light fractions *(The Oil and Gas Journal, January 1, page 48)* is all that is under construction at the present time, though other units are planned for later erection.

Fish Engineering Corp., Houston, has the contract for the cycloversion unit. The chemical plant is being built by Tellepsen Construction Co., Houston.

The McCarthy organization was disclosed last week to have purchased 32 acres of land near Beaumont to serve as a shipping point for products from the installation at Winnie. The land is on the Neches River adjacent to Port Neches. Plans call for a 6-in. pipe line from the Winnie absorption plant to transport gasoline, and the construction of a dock at the shipping point.

Gulf Will Build Plant Using Crane County Gas

Gulf Oil Corp. will construct a natural-gasoline plant with a capacity of approximately 40,000,000 cu. ft. of gas per day in Crane County, Texas, about 30 miles southwest of Odessa. Completion is scheduled late in 1949.

The plant, which will be a high-pressure, absorption-type gasoline-extraction unit and will operate at approximately 600 psi., will utilize gas produced from the Sandhills, Waddell-Henderson, University-Waddell Ellenburger, and C-Bar Silurian pools of Crane County. It will be designed to extract 80 per cent propane, 98 per cent butane and all of the 26-lb. natural gasoline.

Included in the facilities will be nine 1,200-hp., angle-type, gas engine-driven compressors.

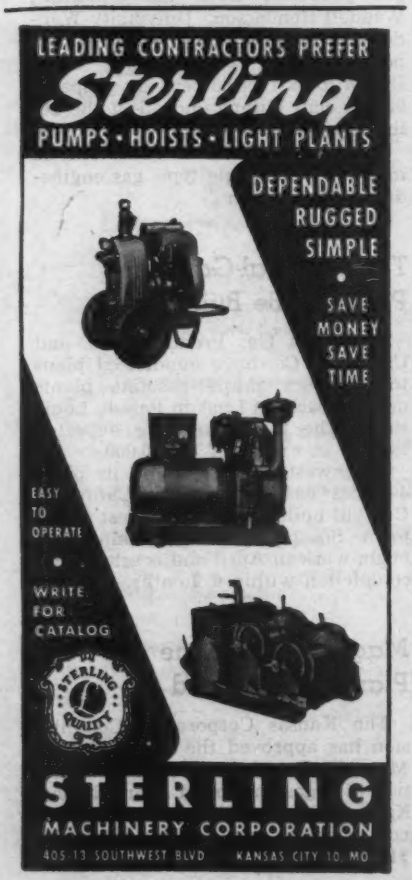
Two Natural-Gasoline Plants to Be Built

Southwest Gas Producing Co. and California Co. have announced plans to construct natural-gasoline plants near Dubach, in Lincoln Parish, Louisiana. The two plants are expected to cost in excess of $5,000,000.

Southwest Gas will build its plant 4 miles east of Dubach. California Co. will build a few miles west of the town. Southwest Gas is planning to begin work in April and is scheduling completion within 6 months.

Magnolia Gasoline Plant Is Approved

The Kansas Corporation Commission has approved the application of Magnolia Petroleum Co. for construction of a gasoline plant near Ulysses, Kans. Company officials estimate the cost of plant and gathering lines at $1,800,000.



REFINING

Pennsylvania Railroad Orders 114 Diesels

The Pennsylvania Railroad has placed orders for 114 additional diesel engines and according to M. W. Clements, president, the company is "well under way on one of the largest diesel locomotive installations in the country."

The latest orders call for 14 road freights and 100 switchers at a total cost of $16,000,000. The new orders bring the postwar equipment program to a total of 374 diesels, 4,400 freight cars, and 395 passenger cars. Cost is estimated at $149,000,000.

Company officials said that by May all important east-west through passenger trains will be handled by diesel power in the nonelectrified territory west of Harrisburg, Pa.

The Pennsylvania Railroad is the nation's largest coal-carrying railroad.

Shell Chemical Building Petroleum Additives Unit

Construction is now under way on Shell Chemical Co.'s new synthesis unit at Martinez, Calif., for the manufacture of addition agents for petroleum products.

"Petroleum additives" are products which are blended with lubricating oils and other petroleum products to improve their performance and lengthen use-life.

Ralph M. Parsons Co. is the contractor for engineering and construction of the plant, which is scheduled for completion late this year.

Texaco Develops New Grease-Testing Machine

NEW YORK.—A machine for determining the more important properties of lubricating greases has been developed by the research laboratories of The Texas Co. at Beacon, N. Y. This machine is claimed to show, in a very short time, data on all the more essential properties of a grease and how it withstands the rigors of roller and ball-bearing service.

Requiring a standard run of 2 hours only, the machine can be operated on a 32-gram charge of grease and at a wide range of temperatures and speeds. It measures starting and torque values, maximum and running temperatures, grease adherence to bearing and housing, leakage characteristics, and physical and chemical changes in the grease during service. The most recent improvements include application of loads by hydraulic means, automatic controls, and a wider variety of speeds with one motor.

Information obtained already shows that the texture of a grease, rather than its specific hardness or softness, is one of the most important factors in determining tendency toward leakage in service. Similarly, the old theory that a milled grease is better than an unmilled grease for use in antifriction bearings has been exploded by the data developed from the use of this machine, Texaco technologists say.

Program for W.P.R.A. Meeting Announced

The completed program for the Western Petroleum Refiners Association annual meeting to be held in the Galvez and Buccaneer hotels, Galveston, April 5-7, has been announced.

Floor discussion will follow the presentation of business and technical papers and reports. They are scheduled as follows:

Monday, April 5

"Motor Gasoline Refining and Utilization," W. M. Holaday, Socony-Vacuum Laboratories, Inc., New York.

Tuesday, April 6

"Improving Engine Lubricating Oils Through the Use of Additives," C. J. Livingstone and W. A. Howe, Gulf Oil Corp., Pittsburgh, Pa.; "Application of the Fluid Catalyst Technique to Catalytic Cracking and Hydrocarbon Synthesis," Dr. R. W. Krebs, Esso Laboratories, Baton Rouge, La.; "National Petroleum Council — Its Purposes and Functions," Walter S. Hallanan, Plymouth Oil Co., Pittsburgh.

Wednesday, April 7

"Oil Shale As a Source of Synthetic Fuels," Boyd Guthrie and John G. Tripp, oil shale demonstration plant, U. S. Bureau of Mines, Rifle, Colo.; "Appraisal of Gas Synthesis Operations," R. C. Alden and A. Clark, Phillips Petroleum Co., Bartlesville, Okla.; "How Goes the Labor-Management Act," J. Copeland Gray, member of National Labor Relations Board, Washington, D. C.; and "World Federation," W. T. Holliday,

Standard Oil Co. (Ohio), Cleveland, Ohio.

Election of board of directors and officers is scheduled for the first day of the meeting. Committee meetings, dinners, and other social activities are scheduled over the 3-day meeting.

New Oxygen Process Aids Synthetic-Gasoline Output

A new process whereby pure gaseous oxygen in tonnage quantities may be manufactured has been announced by Elliott Co., Jeannette, Pa. Through the use of this process plants may operate indefinitely without shutdowns for periodic "defrosting" and can therefore remain on stream continuously.

Quantity oxygen is an essential of the new synthetic gasoline processes which are being planned. The use of oxygen with natural gas opens up a new source of supply of gasoline, fuel oil, and chemicals. Even substitute natural gas can be made at the mines by the gasification of coal through the use of oxygen, and piped to large cities and industries.

In the process, preconditioned air is cooled to below minus 300° F., and distilled in a special distillation column into its components, oxygen and nitrogen. The oxygen is then piped to the process where it will be used. The nitrogen produced is so pure that it can be used as a chemical raw material for bright annealing in steel mills or other purposes.

Labor Dispute Halts Shell Refinery Work

HOUSTON.—Construction work on an estimated $60,000,000 worth of improvements at Shell Oil Co., Inc.'s refinery at Deer Park, near Houston, was halted March 25 as a result of a contractor-union labor dispute involving American Federation of Labor building craftsmen.

C.I.O.-affiliated members of the Oil Workers International Union continued on the job at Shell's 85,000-bbl. daily Deer Creek refinery, and production operations were normal.

The tieup of work on Shell's chemical plant being built at Deer Park and on refinery units under construction originated with the painters' union which began picketing the projects as the outgrowth of a controversy with three contractors over payment of a differential for scaffold work.

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Synthetic Rubber Use Off Slightly in January

Consumption of synthetic rubber by domestic manufacturers declined slightly during January and totaled 43,002 long tons compared with 43,230 tons in December, according to the monthly report of the Rubber Manufacturers Association.

At the same time consumption of natural rubber increased from 56,284 tons in December to 58,065 in January, making the total for the month 101,067 long tons not including 25,539 tons of reclaimed rubber. In January 1947 total consumption was 104,092 tons, of which 58,764 tons were synthetic. The January 1948 consumption of synthetic rubber was made up of 33,964 tons of G.R.S., 2,973 tons of Neoprene, 5,384 tons of Butyl, and 681 tons of G.R.A. (N. Types).

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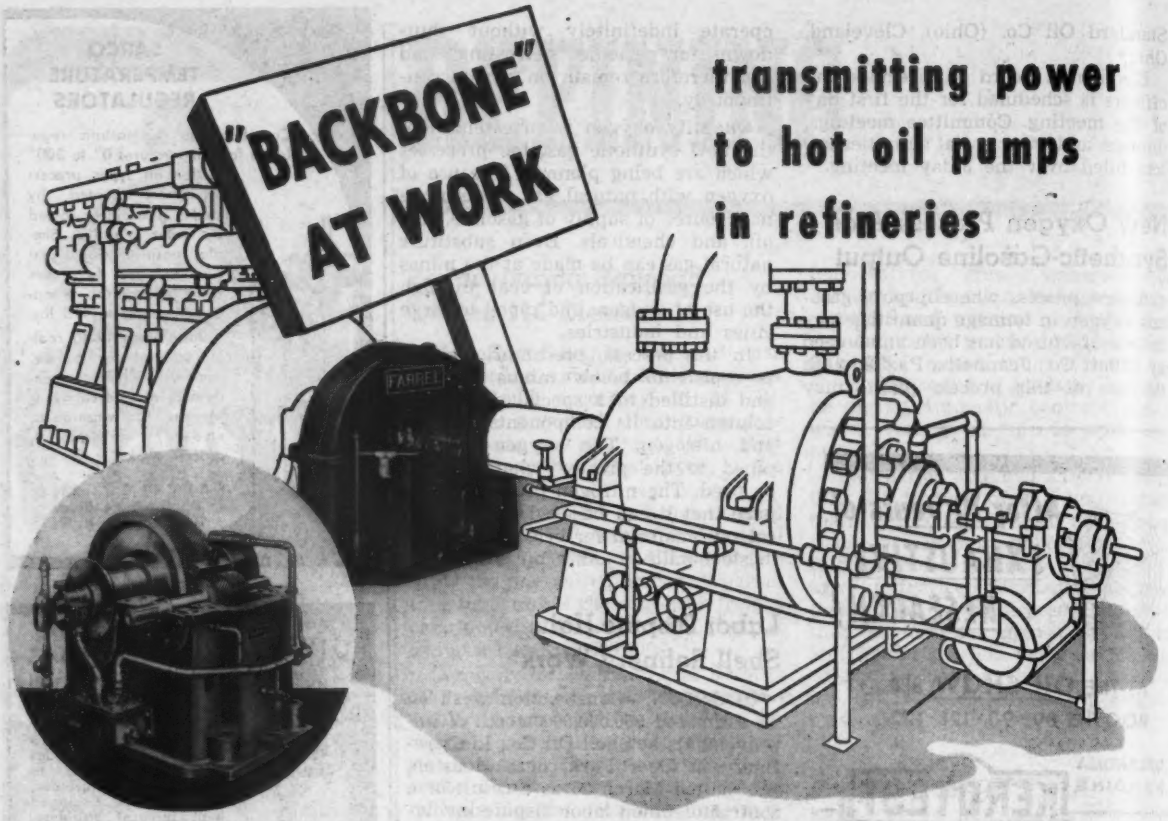

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For further information on Farrel gears, gear units and the Farrel-Sykes method of precision generation write for descriptive bulletins.

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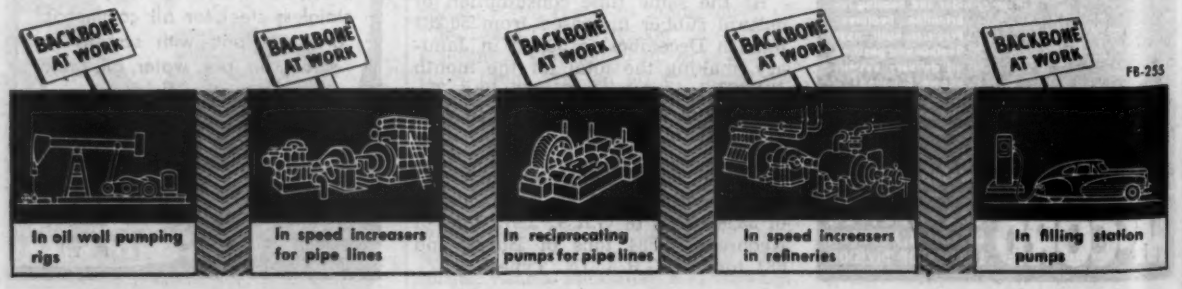
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In reciprocating pumps for pipe lines
In speed increasers in refineries
In filling station pumps

FB-253

PIPE LINES

Interstate Pipe Line Co. To Test Aluminum Pipe

INTERSTATE OIL PIPE LINE CO. will install one-half mile of 6-in. and 1 mile of 4-in. aluminum pipe in regular pipe-line service in two areas in the Southern Division where excessive corrosion is an acute operating problem, according to the current issue of "The Liner," a company publication. Assisting in this installation will be welding experts and technical advisors of Aluminum Co. of America.

The full-scale test of aluminum pipe under field service conditions, scheduled to begin around April 5 in Interstate's Southern Division, will be significant for the crude-oil pipe-line industry.

Besides testing the new pipe material's resistance to unusually corrosive conditions, the experiment is also a practical field test of the value of aluminum as a substitute for critically scarce steel for the new pipe lines.

Each of the two test installation locations were selected because of the particular corrosion problem which exists in that area. In south Arkansas, where the sour crudes from the Dorcheat-Macedonia and McKamie fields are responsible for extremely rapid internal corrosion, a half-mile each of 4-in. and 6-in. aluminum line will be installed in the Interstate system. The other half-mile of 4-in. will be placed in service in South Louisiana, where soil conditions along the banks of the Intercoastal Canal cause excessive external corrosion.

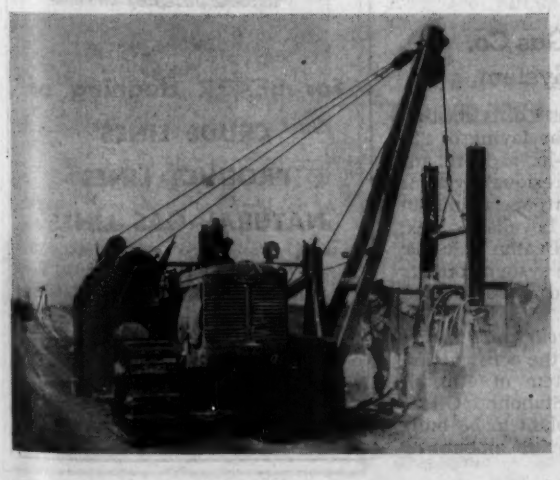
The pipe will be the first aluminum pipe installed anywhere in crude-oil service, and it will be the first aluminum pipe to be field welded by the relatively new Heliarc welding process..

The unusual feature of the new welding process is that it uses a cloud of argon gas to shield the molten aluminum from oxidation while the weld is being made. Unlike most forms of electric welding, the Heliarc process uses a tungsten electrode which is not consumed in making the weld; and since no flux is necessary due to the argon gas blanket around the arc, there are none of the customary fumes and sparks. Only a very brilliant white arc is visible during the welding process. So brilliant is this arc, in fact, that the welder must wear darker than normal goggles.

In making welds under field conditions with the new process, it will probably be necessary to place a tent around the welder to keep the wind from blowing the argon blanket away from the weld.

Aluminum pipe for pipe-line service possesses several theoretical advantages, which, if proved by the test, may offset in part the higher cost of an aluminum line.

Besides being more plentiful at present than steel, and more resistant to certain types of corrosion, aluminum pipe is considerably lighter than steel. Six-inch steel pipe of the type used by Interstate weighs 18.97 lb. per foot, while aluminum pipe of the same size weighs only 6.55 lb. per foot. A 40-ft. joint of 6-in. aluminum pipe weighs only 262 lb., while its steel counterpart weight 758.8 lb.



Double-rock drills handled by boom-tractors in preparing for blasting in TXL field, West Texas, along the right-of-way of the Jal, N. M.-Midland, Tex., section, contracted by Morrison Brothers Construction Co., Inc. The section is a part of the Jal-Cushing, 500-mile, 20-22-24-in. crude-oil system of Texas Pipe Line Co., Shell Pipe Line Corp., Empire Pipeline Co., and Sinclair Refining Co.

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Four-inch aluminum pipe weighs 3.73 lb. per foot, as against 10.97 lb. for steel.

Though aluminum is not as strong as steel, the experimental pipe installed in Interstate's system will be tested to 1,000 psi., and the actual working pressures to be allowed will be close to this pressure..

Sohio, Buckeye to Lay Cygnet-Cleveland Line

Sohio Pipe Line Co. and Buckeye Pipe Line Co. are undertaking construction of the Cygnet-Cleveland, Ohio, 120-mile, 12¾-in. o.d. crude-oil pipe line.

Coating operations for the application of Somastic have been planned for plant locations at Fostoria and Brook Park, Ohio, which will be supervised by M. J. Lane and W. G. Glenn.

Work Progresses on Maracaibo Big Inch

Welding was under way late in March for construction of the 24-in. and 26-in. crude-oil line of Creole Petroleum Corp. from Ule tank farm at La Salina on Lake Maracaibo to the sites of refinery facilities being built at Amuay Bay on the Paraguana Peninsula, Venezuela. Overland length of the project is regarded as 135 miles. In addition there will be nearly 20 miles of submarine line.

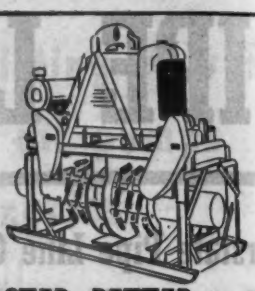
Williams Brothers Co., the contractor for the undertaking, is now operating a complete spread with approximately 20 welders. Guy S. Connors, vice president of the contracting company, visited the project early this week.

Construction is approximately half completed for the Las Mercedes-Pamatacual, Venezuela, 157-mile 16-in. crude-oil line being laid by Williams Brothers Co. for S.A. Petrolera Las Mercedes (The Texas Co. and Caracas Petroleum Co.). All pipe for the project has been delivered.

Stanolind Oil & Gas Co. Starts 320-Mile System

Stanolind Oil & Gas Co. is starting work this week for the laying of 320 miles of pipe from 2-in. to 30-in. for the gathering and residue systems serving gasoline plant operations in Slaughter pool near Levelland, Tex. Contract was let to Deaton & Sons. The 30-in. pipe for the system consists of low-pressure lines of spiral-welded pipe for 2 lb. sedvice.

In the fall of this year some initial work will be done on the construction of the gathering system of 4-in. to 30-in. pipe to serve Stanolind Oil & Gas Co.'s synthetics plant to be built in Hugoton field. The full amount of



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pipe to be used for the Hugoton system has not been determined yet. The laying of the Stanolind Oil & Gas Hugoton lines will probably continue during an 18-month period.

East Ohio Will Lay 20-In Line to Akron

East Ohio Gas Co. is preparing to start construction within a few weeks for the 84-mile, 20-in. line to be laid from St. Clairsville to Akron, Ohio. W. O. (Jack) Poston, superintendent, will handle operations for the contractor, Williams Brothers Corp. During 1947, Poston supervised the Williams Brothers job of laying 52 miles of 20-in. for East Ohio in the Barberton, Ohio, area.

Socony-Vacuum Prepares For Two Products Lines

Socony-Vacuum Oil Co., Inc., will commence operations in June for laying the 119-mile, 6-in. Portland-Augusta-Bangor, Me., products line. About the same time construction will get under way for Socony-Vacuum's 154-mile 8-in., Malvern, Pa.-Binghamton, N. Y., products line. Somastic coating will be used on both lines.

El Paso Plans 18-In. Outlet From West Texas

El Paso Natural Gas Co. has filed an application with the Federal Power Commission requesting a permit to build an 18-in. natural-gas line from east-central Upton County, Texas, to a connection with its Permian Basin-California 26-in. line at Jal, N. M.

This line would transmit gas from reserves which may be developed in the Benedum field area.

El Paso Natural also proposes to build 601 miles of 26-in. loops on the Jal-California line, which is now in operation. Such looping is calculated to increase the capacity of the line from 305 million cubic feet per day to 605 million cubic feet per day.

Trans-Arabian Draws $80,000,000 for Project

Trans-Arabian Pipe Line Co. has drawn an additional $35,000,000 against its $125,000,000 credit it arranged with insurance companies in 1947, a report to the Securities and Exchange Commission at Washington revealed. Total drafts against the credit now are $80,000,000.

Trans-Arabian is jointly owned by The Texas Co. and Standard Oil Co. of California. This arrangement will be enlarged to admit Standard Oil Co. (N. J.), and Socony-Vacuum Oil Co., Inc., when current legal problems are overcome.

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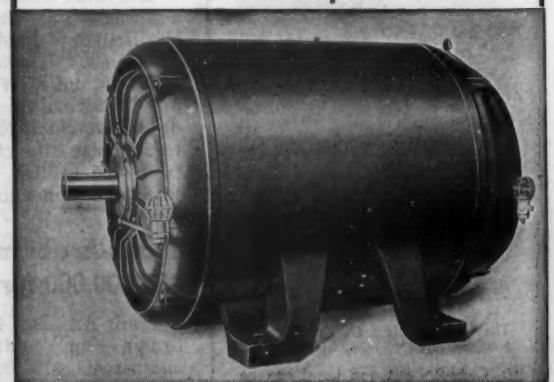

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Among the

Drilling Contractors

J. J. Cody, San Antonio, has received contract to drill Ray A. Albaugh 1 Nellie DeLoache, wildcat in northwest Hockley County, West Texas. Venture is on 20½ Labor-Block with test spotted for 440 ft. from north and east lines, Labor 16, League 77, Reeves County School Land Survey.

Miller & York, Bakersfield, is scheduled to drill 13 wells for Standard Oil Co. of California at Kern River. Same contractor will drill test in Mount Poso field, California, for Harry Sheldon and George Allen, Long Beach.

Spartan Drilling Co., Shreveport, is making hole on Sohio Petroleum Co. B-1 Annie Smith, C NW SE 8-16s-17w, northwest diagonal offset to G. H. Vaughn discovery northwest of El Dorado, Union County, Arkansas.

Fowler Drilling Co., Long Beach, has contract to drill wildcat for four Texas operators — R. L. Wheelock, J. L. Collins, J. S. Abercrombie, and J. L. Porter—in 24-3s-9w, Kraemer area, Orange County, California.

Oil Well Drilling Co., Dallas, has brought in a producer, its 1 Allison, wildcat in Section 1, Block DA-6, GC&SF Survey, 18 miles southeast of Rock Springs, Edwards County, West Texas. Pay is Ellenburger at 4,686-715 ft.

Union Drilling Corp., Tulsa, has been granted an Oklahoma charter with $80,000 capital stock. Incorporators are Ray M. Sexton, Tulsa, and W. N. Smiley, and Tom F. Carey, both of Oklahoma City.

Western Drilling Co., Longview, is drilling American Republic Corp. 1 Clay-Atkins Unit, wildcat in R. Smith Survey A-1384, 4 miles west of Christoval, Tom Green County, West Texas.

Burden & Kemp are contractors for James E. Kemp and Magnolia Petroleum Co. 1 Stanton, 9-7n-2w, La-Grange field, Adams County, Mississippi.

Quigley Drilling Co. has a probable oiler in south end of Pondera field, Montana, its 1 Dubois, NW SW NW 22-27n-4w. It is an east offset to same operator's 1 Christensen, which opened south end of field last year.

H. R. Theck is drilling Placid Oil Co. 4 Forrester, W. Nelson Survey A-963, 8 miles west of Sanger, Denton County, North Texas.

Santa Maria Drilling Co., Long Beach, is contractor for Sunray Oil Corp. 5 Enos, Santa Maria Valley field, California.

Included in this group picture are equipment-company representatives and crew members of Blount Drilling Co. on location at an Ohio Oil Co. well in the Eunice, New Mexico, area. Front row: F. R. Cary, Blount Drilling Co.; Paul Lathrop, Langdon Tent & Awning Co.; and V. L. Greene, driller; C. R. Ford, Joe Walden, F. L. Brown, E. F. Demis, and Herbert Delay, all of Blount. Back row: C. C. Calhaun and A. V. Nichols, driller, Blount; H. M. McBroom and Fred A. Dimit, Unit Rig & Equipment Co.; W. D. Tharp and Brooks Brininstool, Blount; and O. T. Reeves, Reed Roller Bit Co.

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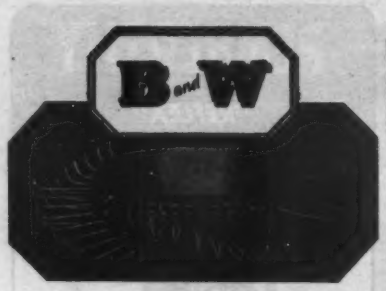

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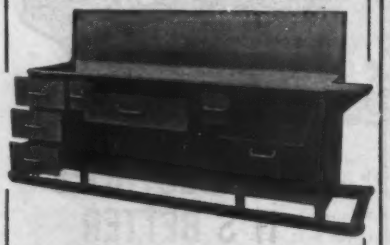

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RUNNING High

Nicklos Drilling Co. Houston

Growth.—Nicklos Drilling Co., with headquarters in City National Bank Building, Houston, has shown gradual but steady growth since it was organized in 1935 with one steam rig. Founder of the company and its present chairman of the board is E. J. Nicklos, who first entered the contracting field in Mexico in 1913.

E. J. NICKLOS

C. F. NICKLOS

The company now has seven heavy-duty steam rigs. During the 13 years since its organization it has drilled 325 wells in Texas, Louisiana, and Alabama. Footage drilled by the company as of December 31, 1947, totaled 2,459,810 ft. It has confined its activities to contract drilling and not entered the production field, although Nicklos himself holds some production in South Louisiana and Texas as an individual.

Personnel.—Besides E. J. Nicklos as board chairman, the company includes C. F. Nicklos, president; D. E. McMahon, vice president and manager; and G. E. Nicklos, vice president. Both E. J. Nicklos and his brother, C. F. Nicklos, have long careers in the oil industry. Leaving Mexico in 1921, E. J. Nicklos became division manager for The Texas Co. in Oklahoma, Kansas, and Kentucky, in 1923. Six years later he left The Texas Co. to become vice president in charge of production for Continental Oil Co. and held that position until the drilling company was organized.

C. F. Nicklos was in Venezuela from 1920 to 1927. Previously he spent a number of years in Mexico. In 1927 he joined The Texas Co. and was Rocky Mountain division superintendent with offices in Denver at the time he became associated with the drilling company in 1943.

Field personnel of Nicklos Drilling Co. includes K. R. Simmons, drilling superintendent at the Eunice, La., field office; and E. C. Swenson, R. T. Volentine, A. C. Heflin, Virgil Sullivan, and O. D. Grafton, toolpushers. All of the toolpushers have come up through the ranks and each of them has more than 10 years with the company.

Sidelights.—Nicklos Drilling Co. has to its credit the drilling of the discovery well in Tepetate, Ville Platte, Valentine, and North Richie fields in South Louisiana. At the present time, the company is conducting drilling operations in the LaBelle area near Beaumont, Texas; West Tepetate, Acadia Parish, Louisiana; Pine Prairie, Evangeline Parish; Valentine, Lafourche Parish; and in Pointe Coupee Parish where it is drilling a wildcat for The Texas Co.

Stewart Drilling Co. has contracted to drill British-American 2 Bailey Johnson, NE NE 29-16n-25, Cypress Lake area, Miller County, Arkansas.

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HOUSTON

Exploration and Drilling

Canadian Completion Attempt Draws Wide Attention

THERE is a substantial amount of interest and watchful waiting in many circles, as Gulf Oil Corp. works at completion tests on its Pincher Creek discovery in southwestern Alberta, Canada, about 16 miles north of Glacier National Park, Montana. Canadian and United States oil men are watching it for its influence on more foothills plays in Canada and farther south in the United States along the front of the mountains.

The well in LSD 15 24-3-29w4 flowed for 2 hours through ⅛-in. and 1/16-in. chokes on 2½-in. tubing, at rates indicating it was good for 8,000,000 to 10,000,000 cu. ft. of gas and 70 to 100 bbl. of 54° gravity condensate per day, tubing pressure 2,700 psi. Then gas expansion froze the tubing and pumping in hot oil and alcohol failed to clear the iced up condition. Total depth is 11,927 ft., in the Madison lime, with 7 in. casing set at 11,755 ft., cemented from top to bottom with 6,000 sacks. Bottom-hole pressure of 5,575 psi. was registered before cementing.

Pincher Creek is a structure in the overthrust belt along the front or east side of the Rockies, just west of the Alberta syncline. In this area huge blocks of sedimentary rocks have been thrown upward along faults and thrust eastward over the younger sediments. These huge blocks are in turn broken by local faulting into upthrown and downthrown wedges, which complicate the local geology of any given structure. It is at least theoretically possible, if it hasn't actually happened, for a well to start drilling through a section of rocks, cut a local fault, and start in drilling a second time in another section of the same age rocks as those already drilled higher in the hole. If drilling continued in an extremely deep hole, the well might eventually go through the entire overthrust block and then start drilling in rocks as young, possibly even younger, than those at the surface of the ground.

This is a discouragingly complex type of geology to attempt to unravel, and geophysicists have found that interpretation of seismograph records is just as difficult. However, Turner Valley, the richest field ever found in Canada, and about 80 miles northwest of Pincher Creek, is located on just such a structure. This field was discovered in 1924, and is still the scene of some drilling. It produced from the Madison lime (Mississippian) through a closure of about 5,500 ft. on the east side and 4,500 ft. on the west. Some 20 years later, Jumping Pound field in the Madison was opened, about 25 miles northwest of the north end of Turner Valley, but it is apparently small in area, mostly gas and condensate, deep and expensive drilling. Now comes Pincher Creek, about 75 miles southeast of the south end of Turner Valley.

This overthrust belt extends down through Montana and several leasing plays and some drilling activities have persisted through the years. A fair amount of seismograph work has been carried on here in recent years, in the hope of solving the complex interpretation. The lure of another Turner Valley is just as potent south of the border as it is among the Canadian operators.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

WASHINGTON.—Union Oil Co. appeared to have made the first commercial discovery in the state when their sixth exploratory venture in the Ocean City area of Grays Harbor County flowed 1,000,000 cu. ft. of natural gas daily. However, the flow died down to an uncommercial rate and efforts to restore production have been unsuccessful. The company plans to go back into the hole which is currently bottomed at 6,300 ft.

ROCKY MOUNTAIN.—In Wyoming, water was recovered by Pure Oil Co. on drill-stem test of the Rocky Point wildcat in Campbell County, and the operator is coring ahead. Casing was run on the same company's Poison Spider wildcat at 13,840 ft., the area's depth record, and the well will soon be tested. Stanolind Oil & Gas Co. 2 Orchard Unit found a new producing formation at Torchlight field in the Madison sand. In Utah, Byrd-Frost, Inc., et al 1 Redd, Boulder Knoll wildcat, has been abandoned after failing in the Madison at 8,678 ft., total depth.

CALIFORNIA.—The next operation at Continental Oil Co.'s deep wildcat in Kern County will be decided by the cores of a drilling break zone at 13,077 ft.

CANADA.—Leduc field gets nine new oil wells, two of which extend the producing area to the south.

TEXAS GULF COAST.—Hamill 1 Duncan, new deep sand discovery on the north side of Egypt field, Wharton County, gaged 3,085,000 cu. ft. of gas and 99.5 bbl. of condensate from 6,720-26 ft.

SOUTH LOUISIANA.—The California Co. 12 Brady, new pay discovery in South Barataria field, Jefferson Parish, has reported a potential gage of 136 bbl. of condensate per day.

PERMIAN BASIN.—Wilshire Oil Co.'s first operation in basin, a discovery prospect about 5 miles east of the McElroy field in Upton County, has prepared for a second drill-stem test.

SOUTHWEST TEXAS.—San Patricio County's new discovery, A. O. Morgan 1 Crabb, may be included in West Sinton field as an extension to the field. The same operator has completed a reworked dry hole south of West Sinton as a shallow sand producer.

TEXAS GULF COAST

Deep Sand Is Opened In North Egypt Field

HOUSTON.—A deep sand has been opened on the north side of the Egypt gas field, Wharton County, at Claud B. Hamill 1 F. B. & D. Duncan, in Alex. Edgar Survey. Perforated at 6,720-26 ft., the well gaged 3,085,000 cu. ft. of gas daily along with 99.5 bbl. of 61°-gravity condensate through a ¼-in. choke. Tubing pressure 2,335 psi. This well is approximately 4,000 ft. north of the shallow production.

Cities Service Oil Co. 1 Mrs. S. H. Baker, wildcat discovery prospect in eastern Victoria County, approximately 3 miles southeast of Inez and near the Jackson County line, flowed gas and salt water on test through perforations at 4,468-71 ft. and operators were making preparations for final completion in the 5,240-54 ft. sand as a gas-condensate well. Test made previously in this lower sand, through perforations at 5,249-51 ft. had flowed gas with some condensate with 2,475 psi. working pressure, through ¼-in. choke top and bottom. Total depth is 6,816 ft., with 5½-in. casing set to 5,334 ft. Top of Greta sand was reported at 4,525 ft.

Hinkle Drilling Co. 4 G. M. Adcock, an offset extension on the southeast side of North Port Neches field production in Orange County, gaged 163 bbl. of 37°-gravity oil per day through a ½-in. choke with 1,300 psi. flowing pressure on the tubing and a gas ratio of 624. Production is through perforations at 8,773-77 ft. Sands were cored in this well from 8,746-79 ft.

A new deep sand in Fannett field, Jefferson County, has been opened by Gulf Oil Corp. A-3 R. S. Jackson, located in W. H. Smith Survey. On potential gage the well flowed 6,220,000 cu. ft. gas and 74 bbl. condensate per day through a 10/64-in. choke, with gas-condensate ratio 49,365, with tubing pressure 3,250 psi. Gravity 47°. Total depth of 13,503 ft. with production through perforations at 11,045-53 ft.

In Live Oak County, Continental Oil Co. 1-E Albert West opened a new gas-condensate pay in Albert West pool. Top of pay 7,200 ft. in Massive Wilcox, with perforations at 7,256-66 ft. On potential gage the well flowed 17,500,000 cu. ft. gas per day on open flow, with gas-condensate ratio 35,000. The shut-in pressure is 2,725 psi.

There were 30 new locations reported this week of which 5 are wildcat starts, 1 each in Austin, Karnes, Lee, Matagorda and Wharton counties. Three successful wildcats were completed, one each in Austin, Jefferson and Live Oak counties. Six wildcats were dry, two in Chambers, and one each in Jackson, Jefferson, Live Oak and Montgomery counties.

TEXAS GULF COAST (DISTRICTS 2 AND 3) SUCCESSFUL WILDCATS

Austin County: New oil discovery in New Ulm Area—Gulf Oil Corp. 1 Allen Lesikar et al, in A. Kuykendall League, A-243 2½ mi. W of New Ulm, TD 10,017 ft., top sand 9,612 ft., perf. 9,612-18 ft., IP: 44 bbl. oil per day through a ⅛-in. choke, and 1,000,000 cu. ft. gas per day, GOR 20,020, TP 2,100 psi., gravity 38°, no water.

Jefferson County: New gas-condensate deep sand Fannett—Gulf A-3 R. S. Jackson, in W. H. Smith Sur. A-198, TD 13,503 ft., top sand 11,045 ft., perf. 11,045-53 ft. IP: 6,220,000 cu. ft. gas per day and 74 bbl. condensate per day through a 10/64-in. choke, GOR 49,365, TP 3,250 psi., gravity 47°, no water.

Live Oak County: New gas-condensate pay Albert West pool—Continental Oil Co. 1-E Albert West, in James Warmsley Sur. 166, top of pay 7,200 ft. Massive Wilcox, TD 7,289 ft., perf. 7,256-66 ft., IP: 17,500,000 cu. ft. gas per day on open flow, GOR 35,000, shut-in pressure 2,725 psi., no water.

TEXAS GULF COAST (DISTRICTS 2 AND 3) WILDCAT FAILURES

Chambers County: Hilary Hebert and J. C. Means, Jr., 1 Leila W. Rearwin et al, in H&TC Sur., A-127, 2 mi. S of production in Anahuac field, dry, TD 9,483 ft.

Chambers County: Sun Oil Co. D-2 White Estate, T&NO Sec. 130, Willow Slough area, dry, TD 9,517 ft.

Jackson County: Hunt Oil Co. 1 Robinowitz Bros., Block 7, Allen Pasture subd., of J. White Sur., 6 mi. S of Ganado, dry, TD 7,500 ft.

Jefferson County: Sun Oil Co. 3 McFaddin Tr., in Pelham Humphreys Lge., off east flank of Spindletop dome, dry, TD 5,963 ft.

Live Oak County: Curtis Singleton 1 E. C. Probst, in GM&D Sur., A-213, 5 mi. NE of Oakville, dry, TD 6,619 ft.

Montgomery County: Hunt Oil Co. 1 Mrs. S. Golden et al, in John Taylor Sur., A-547, 12 mi. S of Conroe townsite, dry, TD 7,520 ft.

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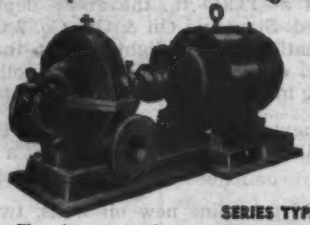

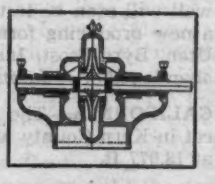

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CALIFORNIA

Continental Wildcat Is Coring at 13,077 Ft.

LOS ANGELES.—Continental Oil Co.'s deep wildcat venture in the San Emigdio area of Kern County, the L-2 Kern County Land Co., 8-11n-21w, has reached a depth of 13,085 ft. and drilling operations are nearing a conclusion. Operators have reported a slight drilling break at 13,077 ft. and are waiting for a core of this zone before deciding the next move. If the core shows oil sand, the well probably will be cored deeper. If the core does not look encouraging, however, operators will probably start testing out of the hole.

This test has cored several possible productive zones on the way down, but these zones have appeared too tight for commercial production. The well has shown that possibilities of production do exist in this area, however, and the result will probably be several additional tests drilled before the area is abandoned.

Superior Oil Co. and Independent Exploration Co. have teamed up to explore a 24-square-mile area west of the Lost Hills field on the western side of the San Joaquin Valley. While no wells have been staked so far, it is believed that at least one test will go down in Township 26s-19e.

Seaboard Oil Co.'s extension attempt near the Bacon Hills field in Kern County, the 58-21 Seaboard-Bandini, 21-28s-20e, currently has reached a depth of 5,700 ft. with operators expecting to drill another 3,500 ft. The 58-21 Seaboard-Bandini is considerably down flank from other producers in the Bacon Hills field and successful completion would make the field a major one for the state.

E. W. Pauley has completed his 1 Stewart-Pacific Tube, 9-2s-12w, as one of the best producers in the East Los Angeles field of Los Angeles County and also as a northern extension of the field. At last reports, the well was flowing at the rate of 541 bbl. of oil daily through a choke from the interval 8,411-31 ft., total depth. This well is interesting from the standpoint that drilling crews obtained a successful water shut-off on the first attempt.

CALIFORNIA WILDCAT FAILURES

Kern County, Edison Area: General Petroleum Corp. 22-30 Cottonwood-So. Cal., 30-29s-30e, dry in green siltstone, elev. 1,196 ft., Walker 3,900 ft., TD 4,265 ft.

Temblor Area: Signal Oil & Gas Co. 2 Signal-Westates, 35-29s-20e, dry, elev. 1,937 ft., TD 2,982 ft.

Monterey County, San Ardo Area: Jergins Oil Co. & North American Consol. Oil Co. 2 McCool Three, 10-22s-10e, dry, elev. 580 ft., TD 1,828 ft.

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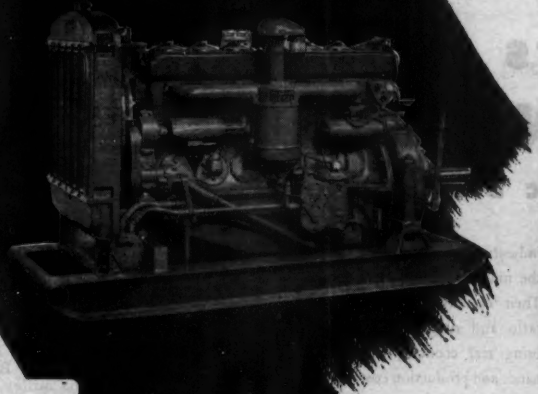

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MISSISSIPPI

La Grange Field Well Flows 115 Bbl. Daily

JACKSON. — Sohio-Petroleum Co.-Roeser and Pendleton 1 De Marco, La Grange field, Adams County, Section 8-6n-2w, has been completed flowing 115 bbl. per day through a 12/64-in. choke, after reperforating 6,196-6,202 ft. with Welex-shaped charged gun. Only other use of this method of perforation in Mississippi has been by Gulf Refining Co. on the 3 W. J. Howard at Baxterville early this week, on a rework job.

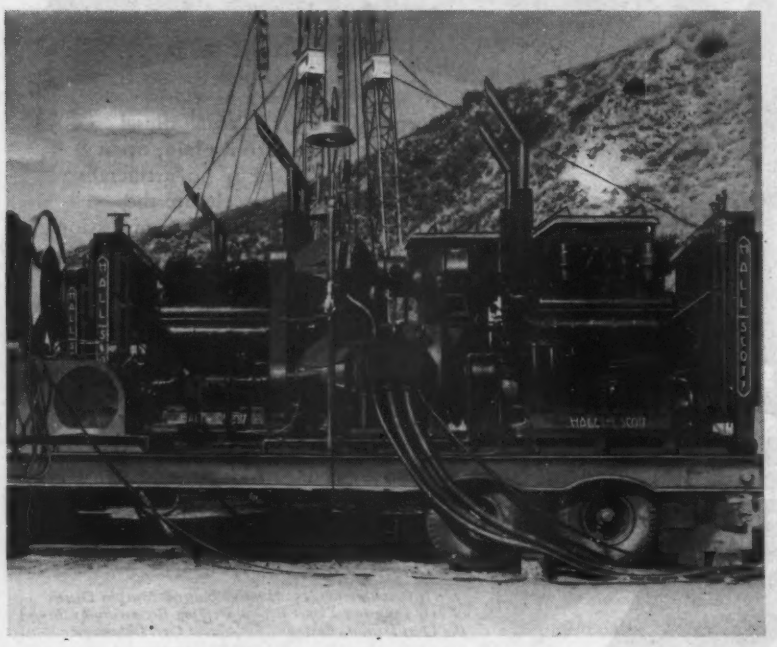
At Oldenburg, Franklin County, Vaughey and Vaughey et al 1 Mrs. M. E. Hester, 25-7n-2e, has cored tight to slightly porous shaly sand in the upper portion of the Lower Tuscaloosa, with show of gas, condensate and oil. Low permeability sand was indicated at 10,415-10,440 and 10,456-10,471 ft. Operators are coring ahead.

James E. Kemp 2 Elizabeth Stanton, 84-7n-2w, in La Grange field, Adams County, has set 5½-in. casing at total depth of 6,210 ft. Electric log and side-wall cores were taken after drilling to total depth which indicated Baker Oil sand 6,144-6,162 ft., assuring a 1,000-ft. north extension for the field.

There were 9 new locations reported this week, all in proven areas, 2 each in Mallalieu field, Lincoln County, LaGrange field, Adams County; and 1 each in Baxterville field, Marion County; Brookhaven field, Lincoln County; Cranfield field, Adams County; Hub field, Adams County; and Yellow Creek field, Wayne County. One wildcat failure was reported in Covington County.

MISSISSIPPI WILDCAT FAILURE

Covington County: Humble Oil & Refg. Co. 1 Zula L. Daughtry, 28-8n-15w, dry, TD 3,117 ft. Tops: Cockfield 1,057 ft., Cook Mountain 1,370 ft., Sparta 1,660 ft., Cap rock 2,227 ft., Anhydrite 2,325 ft.



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N. CENTRAL TEXAS

Throckmorton Test Looks Good in Marble Falls

WICHITA FALLS.—Deep Rock Oil Corp. et al 1 Andrews, 2 miles south of Throckmorton in Block 284, BBB&C Survey, was reported to have recovered oil on a drill-stem test of the Marble Falls at 4,768-78 ft., although it was not confirmed and details were not available. The report stated gas was at the surface in 7 minutes and the recovery was 490 ft. of oil in 50 minutes. Bottom-hole pressure was around 2,025 psi.

A southeast extension of Mississippi limestone production to the Parrott field of Throckmorton County was indicated at Woodley Petroleum Co. 1 Dickie, Block 938, TE&L Survey. Top of the limestone was reported at 4,609 ft., with oil showing from that depth to 4,623 ft. A 1-hour drill-stem test of that interval recovered 120 ft. of oil and 60 ft. of mud cut with oil. Bottom-hole pressure was 350 psi. Hole was deepened to 4,637 ft. and a 90-minute test run, recovering the same amount of oil and mud. Deepening and testing continued, and at 4,643 ft. a 90-minute test returned 40 ft. of oil and gas-cut drilling mud. The fourth test, from 4,643-36 ft., recovered 40 ft. of heavily oil-cut mud in 30 minutes, and apparently determined the extent of pay section. Drilled to 4,700 ft., a 1-hour test from 4,663-4,700 ft. returned only 40 ft. of mud. Operators set casing to 4,674 ft. and were to perforate and acidize.

Continental Oil Co. and Wilcox Oil & Gas Co. 3 G. W. Scaling, Section 15, H&TC Survey, 1 mile southeast of the 1 Scaling and 6 miles southwest of Deer Creek, Clay County, made a successful drill-stem test in the Caddo at 5,519-27 ft. Gas came to the surface in 2 minutes and oil at the end of 42 minutes. Recovery in the pipe was 1,320 ft. of clean oil and 15 ft. of drilling fluid. Bottom-hole pressure was 2,400 psi. In the new Acme field of Clay County, northwest of Deer Creek, S. D. Johnson et al 3 Mobley, Thomas Morehead Survey, flowed 132.8 bbl. of 46°-gravity oil through 12/64-in. choke in 24 hours from the Mississippi at 5,879-99 ft.

NORTH CENTRAL TEXAS (DISTRICTS 7-B AND 9) SUCCESSFUL WILDCATS

Brown County: A. D. Roberts 1 Mack Henry, Seth Ingram Sur., 4½ mi. E Crosscutt, flowed 132 bbl. 44°-gravity oil a day, ¼-in. choke, casing pressure 325 psi., tubing pressure 125 psi., GOR 500 cu. ft., Caddo 2,055-72 ft., TD 2,093 ft.

Callahan County: B. F. Phillips 1 Cunningham & Lawson, Blk. 138, University Lands, 2½ mi. NW Putnam, flowed 3,500,000 cu. ft. gas a day, Flippen limestone pay 562-71 ft., TD, shut-in pressure 175 psi.

Fisher County: Humble Oil & Refining Co. 1 W. F. Davidson, Sec. 59, Blk. 1, HT&B Sur., 1¾ mi. W McCaulley, flowed 141 bbl. 39°-gravity oil in 16 hr., ¾-in. choke, Noodle Creek limestone 3,161-77 ft., TD, tubing pressure 35 psi., GOR 136 cu. ft.

NORTH CENTRAL TEXAS (DISTRICTS 7-B AND 9) WILDCAT FAILURES

Archer County: Floyd Combs 1 J. M. Powell, Wm. Henry Sur., 1½ mi. NE Archer City, dry, TD 1,420 ft. in shale.

Mrs. H. B. Wallace 1 Fee, Sec. 6, SPRR Sur., 3½ mi. NW Holliday, dry, TD 4,147 ft., sand with oil show 4,129-40, 4,145-47 ft., had salt water at TD.

Brown County: C. J. Brown 1 Beulah Car-

michael, Blk. 7, Parrick McGee Sur., 5 mi. NE Grosvenor, dry, TD 2,645 ft., Caddo 1,970 ft., Ranger 2,617 ft.

Cooke County: Voth Bros. Drilling Co. 1 R. J. Riley, A. C. Davis Sur., 6 mi. W Pilot Point, dry, TD 1,710 ft., Ellenburger 1,685 ft.

San Saba County: B. H. Nolen 1 A. Hanna, Juan Hernandez Sur. 78, 6 mi. NE San Saba, dry, TD 1,662 ft., Ellenburger 1,289 ft.

Shackelford County: W. J. Weaver 1 Alexander Trust, Sec. 42, Blk. 13, T&P Sur., SW corner of county, dry, TD 1,865 ft., Sedwick 1,130 ft., Dotham 1,305 ft., Saddle Creek 1,590 ft., Flippen 1,545-63 ft.

Throckmorton County: Hunt Oil Co. 1 J. W. Tharp, Sec. 243, BBB&C Sur., 4 mi. NW Throckmorton, dry, TD 5,665 ft., Mississippi 5,065 ft., Ellenburger 5,273 ft.

Young County: Deep Rock Oil Corp. 1 C. R. Baldwin, on line of Sec. 1,020-1,019, TE&L Sur., 1 mi. NE Eliasville, dry, TD 4,552 ft., Mississippi 4,416 ft.

A. R. Dillard 1 J. L. Cox, Sec. 2,722, TE&L Sur., 6 mi. SE Loving, dry, TD 4,785 ft. in shale, Caddo 4,350 ft.

EASTERN TEXAS

Kaufman Co. Test to Plug Back to Try Paluxy

DALLAS.—Shell Oil Co., Inc., 1 F. E. Lumpkin, dry Smackover test 4 miles southwest of Cedarville in Kaufman County, apparently gave up the Rodessa section between 6,693-6,714 ft., and again plugged back to test the Paluxy. In swabbing down 6,000 ft., total recovery was clear salt water, with a slight show of gas. New plugged-back depth is 5,950 ft., with new perforations in the Paluxy at 5,358-64 ft. Top of the Paluxy is 5,344 ft., by electric log, on elevation of 434 ft.

After many weeks of testing, Magnolia Petroleum Co. and Sinclair Prairie Oil Co. 1 Fair, gas-distillate discovery in the Schofield Survey, southwest of Lindale, Smith County, made final gage of 30 bbl. of distillate a day through ½-in. choke. Pay is in the Rodessa section at 9,512-72 ft. The well was also making a small amount of acid water. Estimate on the gas was said to be 430,000 cu. ft. daily.

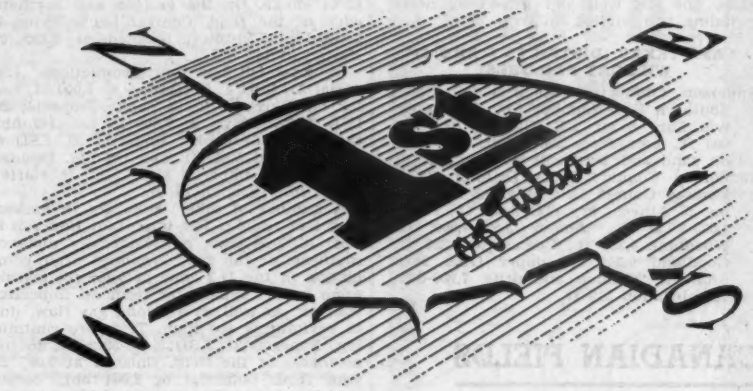
In Marion County, P. H. Pewitt 1-B Ralph, deep test in the Jefferson area, set casing to 8,650 ft. in the Cotton Valley topped at 8,260 ft. Electrical log was said to have shown pay possibilities around 8,400 ft. Total depth is 9,636 ft.

The third well for the Blackfoot field of Anderson County, and the second to be completed in the Rodessa section, made completion potential of 163 bbl. of 43.7°-gravity oil a day through ¼-in. choke. The new well is The Texas Co. 1 Barnard, 1 mile north of Sanders & Murchison 1 Broadway, Pettit discovery of the field, and in the I. P. Rinehart Survey. The Barnard test was dry in the Pettit at 9,800-9,900 ft., and plugged back to 9,100 ft. to complete from perforations at 9,035-60 ft. First acid treatment of 2,500 gal. produced a flow of about 2 bbl. of oil an hour. Second treatment was 10,000 gal., after which it was placed on potential test. Texas 1 Broadway, second well in the field, was also completed in the Rodessa.

Humble Oil & Refining Co. 1 McWatters, Freestone County test, was drilling below 11,321 ft. in hard sand with streaks of shale, some 850 ft. in the Cotton Valley. Humble 1 Whatley, Freestone County, was drilling in shale and lime at 5,966 ft. Humble 1-C Pickering Lumber, Shelby County, was drilling below 7,585 ft. In Smith County, W. F. Nenney 1 Ione Braziel et al, was drilling below 5,619 ft. in Red Beds after recovering stuck drill pipe.

Wood County led all areas in new operations, with six new locations reported in the Merigale-Paul field, and one in the Quitman field. Freestone County had one

Make



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wildcat location in C. L. Brown 1 South Texas Lumber Co., 4 miles east of Teague in the James McAnnuity Survey. It is scheduled to 8,200 ft., with company tools. Rusk County had two new operations in the Henderson field, and Hopkins and Shelby counties each had one new location. Completions for the week were two oil wells, one gas well and three dry holes, including two wildcat failures.

EAST TEXAS (DISTRICTS 5 AND 6) WILDCAT FAILURES)

Anderson County: Continental Oil Co. 1 Southern Pine Lumber Co., Robert Erwin Sur., 6 mi. NE Elkhart, dry, TD 606 ft., core from 596-606 ft. had 1 ft. oil sand and 2 ft. salt water sand.

Henderson County: Delta Drilling Co. 1 Lindsay Gauntt, B. C. Walters Sur., 1½ mi. N Athens, dry, TD 8,406 ft., Pecan 2,563-2,756 ft., Austin 3,597-4,000 ft., Woodbine 4,380 ft., Comanche 5,230 ft., Goodland 6,341 ft., upper Glen Rose 6,820 ft., Massive anhydrite 7,100-8,290 ft., elevation 519 ft.

CANADIAN FIELDS

Nine New Producers Add 1,203 Bbl. to Leduc

CHATHAM.—Nine new producers, under test for various periods, have added an aggregate of 1,203 bbl. daily to the output of Leduc field. Of these wells, two are in the south end which extends the producing area. Continental-Leduc 1, LSD 2, 9-50-26w4, finished at 5,410 ft., has initial production of 151 bbl. through 12/64 choke. East Leduc-South Brazeau 3, LSD 7, 9-50-26w4, immediately to the north, bottoming at 5,407 ft., started with 164 bbl. through 11/64 choke.

Other completions extend to the north end of the field, where Globe-Leduc West 9, LSD 10, 34-50-26w4 finished at 4,964 ft. with 62 bbl. initial through 16/64 choke. Globe-Leduc West 4, LSD 15, same section, at 5,297 ft. started with 168 bbl. through 12/64 choke. On the eastern and northern edge of the field, Central Leduc-Pyrcz 2, LSD 13, 25-50-26w4, finished at 5,295 ft. started at 142 bbl.

Imperial Oil has four completions. Imperial 25, LSD 4, 27-50-26w4 at 5,050 ft. had 116 bbl. through 10/64 choke. Imperial 29, LSD 7, 34-50-26w4 at 5,300 ft. had 147 bbl. through 11/64 choke. Imperial 30, LSD 4, 26-50-26w4 at 5,324 ft. had 132 bbl. through 10/64 choke. Imperial 31 at 5,327 ft. started at 117 bbl. through 10/64.

A number of other wells are in various stages of testing. The important Imperial 9, LSD 16, 3-50-26w4, a considerable distance southeast of the field, swabbed after completing in the D-2 zone at 5,466 ft., getting some water, apparently from an imperfect shut-off, as well as a strong gas flow, due to perforating too high. Tests are continuing. Imperial 37, LSD 5, 35-50-26w4, to the northeast of the field, finished at 5,097 ft. with flush potential of 2,064 bbl., before choking down. Imperial 39, LSD 3, 28-50-26w4, finished in D-3 zone at 5,326 ft., had a flush of 2,616 bbl. a day, based on 8-hour initial run. Imperial 41, LSD 15, 16-50-26w4, in the south-central sector of the field, tested D-2 zone at 5,100 ft. with an oil rise in 40 minutes, and is being finished as a producer at 5,140 ft. Imperial 32, LSD 16, 22-50-26w4, testing at 4,920-5,012 ft., got 260,000 cu. ft. gas and an oil rise in 18 minutes and finished in the D-3 zone at 5,333 ft. Imperial has six other wells testing, seven drilling with three former locations, and four new locations. Three in the south part of the field are Imperial 52, LSD 16 and Imperial 53, LSD 9, both in 20-50-26w4 and Imperial 55, LSD 14, 18-50-26w4. In the north end, Imperial 56 is spotted in LSD 6, 34-50-26w4.

In the central sector of the field, Atlantic Oils 3, LSD 12, 23-50-26w4, standing at 5,331 ft. after a heavy gas blow damaged the well, is removing drill pipe and reconditioning. If the well is abandoned, a second test will be drilled in the same LSD.

In an effort to extend the main producing area 1½ miles to the north and west, East Leduc Co., in conjunction with British American Oil Co., Ltd., will drill in LSD 11, 25-50-27w4.

North and east of the new Woodbend area, Consolidated-Homestead 2, LSD 9, 31-51-25w4, is being started as a joint test by Homestead Oils and South Brazeau Oils.

Eyot.—Ten miles south and a little east of the Leduc field, Imperial-Eyot 1, LSD 2, 28-48-25w4, is below 4,461 ft. and nearing completion. Location is on a seismic high similar to Leduc, but with surface elevation 200 ft. higher.

Gulf operations.—Operations by Canadian Gulf, subsidiary of Gulf Oil Corp., are being carried on in five different areas of Alberta. In the southern foothills, Canadian Gulf-Pincher Creek 1, LSD 15, 24-3-29w4, bottoming at 11,927 ft. with heavy wet gas flow in the Madison limestone, is resetting packer preparatory to testing. Owing to the heavy pressure, over 5,000 lb., operations require unusual caution. In the same general area, but farther to the west, Walter Marr 1, LSD 1, 29-4-29w4, is rigging. In the Delburne area, Central Alberta, Louis Warren 1, LSD 2, 11-37-23w4, is below 2,661 ft. In the Stettler area, farther north and east, Gulf-Piccadilly 1, LSD 14, 16-39-21w4, is below 5,190 ft. after encountering some oil indications. The most northerly test, Alice O'Brien 1, LSD 4, 12-59-3w5 in the Barrhead district is below 4,547 ft.

Turner Valley.—In the north-central Turner Valley area, Royalite-Lowery 8,

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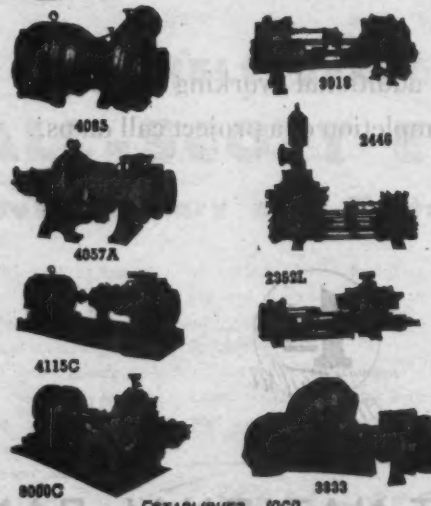

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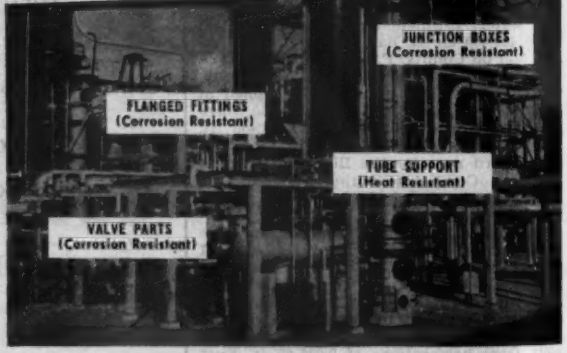

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LSD 9, 10-20-3w5, with Madison limestone at 8,390-8,630 ft. has been finished in the upper porous with initial production of 375 bbl. In the north extension area, Foothills Oil & Gas 27, LSD 9, 4-21-3w5, is below 8,492 ft. and close to the Madison. Royalite-Home 1, west flank test, LSD 11, 32-20-3w5 has spudded.

SOUTH LOUISIANA

South Barataria Well Gages 136 Bbl. Condensate

NEW ORLEANS.—Potential gage on new pay opener at South Barataria pool in Jefferson Parish has been reprted. The California Co. 12 E. P. Brady, Lease 1, in Section 2-16s-23e, flowed 136 bbl. of condensate per day through a 5/16-in. choke, gas-condensate ratio 41,713, tubing pressure 2,850 psi., with gravity 52.1°, and no water in the flow. Total depth is 11,118 ft., with top of sand at 9,688 ft. and perforations at 9,688-9,708 ft.

Barnsdall-Seaboard & Callery & Hurt 1-36 Breton State Lease 1230, Block 36, wildcat, in Breton Sound, 11 miles northeast of Grand Bay field production, is reported to be completing in shallow sands. Drilled to a total depth of 10,609 ft. where salt water flow was encountered and drill pipe was stuck. Operators plugged back for tests through perforations in 9⅝-in. pipe which was set to 9,062 ft.

The Texas Co. 1 Luke Guidrez, wildcat exploration 5,600 ft. southeast of production at Valentine in Lafourche Parish, Section 51-17s-20e, is being tested for production. Total depth is 12,780 ft., with 7-in. pipe cemented at 11,621 ft. for protection. Plugged-back depth is 11,105 ft. Operators are testing through perforations at 11,042-90 ft. Details are not available.

Atlantic Refining Co. B-1 Newport Industries, Inc., Section 12-5s-12w, on east side of present production in the Bivens field of Beauregard Parish, is preparing to begin testing. Total depth is 7,812 ft. with 5½-in. casing set to 7,364 ft. Operators are preparing to perforate for test.

The 13 new locations reported this week included 2 wildcat starts, 1 each in Beauregard and St. Mary parishes. One successful exploratory test was reported for Jefferson Parish, South Barataria field.

SOUTH LOUISIANA SUCCESSFUL WILDCAT

Jefferson Parish: New gas-condensate pay for South Barataria pool—California Co. 12 E. P. Brady, Lease 1, in 2-16s-23e, TD 11,118 ft., top of sand at 9,688 ft., with perforations at 9,688-9,708 ft. IP 136 bbl. condensate per day through 5/16-in. choke, gas-condensate ratio 41,713 ft., TP 2,850 psi., gravity 52.1°, no water.

APPALACHIAN FIELD

Chestnut Ridge Well Tops Oriskany, 7,353 Ft.

PITTSBURGH.—On Chestnut Ridge in Georges Township, Fayette County, SW Pennsylvania, Manufacturers Light & Heat Co. topped the Oriskany sand at 7,353 ft. in No. 8 Barton and 5 ft. in that member there is still no gas. From an elevation of 2,588 ft., the Onondaga chert was logged at 7,145 ft. and there was a showing of 19,000 cu. ft. of gas at 7,194 ft.

In Union district, Barbour County, West Virginia, McCall Drilling Co. completed a second test on Pickens Heirs as a good gas

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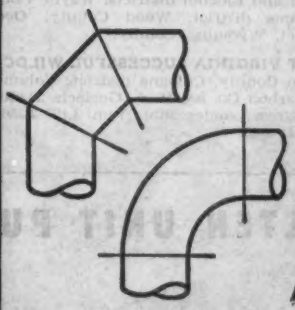

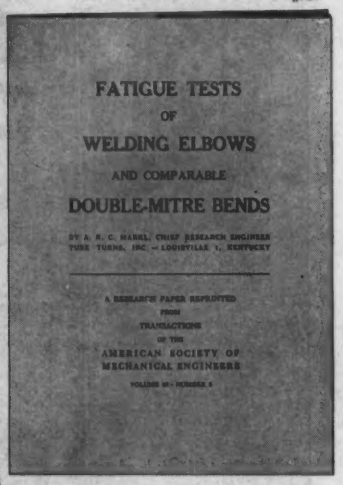

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well gaging 1,078,000 cu. ft. from the Benson sand, total depth 4,380 ft.

In Harts district, Lincoln County, Hope Natural Gas Co. completed 9,203 Robert F. Ferrell as a good Big Lime gas well with a final gage of 2,822,000 cu. ft. from a total depth of 1,401 ft.

New locations totaled 24 in Sherman and Washington districts, Calhoun County; Ravenswood and Union districts, Jackson County; Elk and Poca districts, Kanawha County; Washington district, Lincoln County; Webster district, Marshall County; Harvey district, Mingo County; Adkin and Browns Creek district, McDowell County; Grant and Lincoln districts, Wayne County; Williams district, Wood County; Oceana district, Wyoming County.

WEST VIRGINIA SUCCESSFUL WILDCATS

Mason County, Cologne district: Columbian Carbon Co. 996 H. A. Gerlach, 39,000 cu. ft. gas, shales shot from 3,193-3,586 ft., TD 3,650 ft.

WEST VIRGINIA WILDCAT FAILURES

Mason County, Copper district: Columbian Carbon Co. 995 Clyde Jordan, dry, Big lime 1,397 ft., gas shows 2,920 ft. and 3,385 ft., shot 2,898-3,464 ft., gage 10,000 cu. ft., plugged, TD 3,603 ft.

SOUTHWEST TEXAS

New Discovery Well May Extend West Sinton Field

CORPUS CHRISTI.—A. O. Morgan 1 W. S. Crabb, recent new oil-gas discovery, approximately 2½ miles west of Sinton in San Patricio County, flowed on potential gage 42 bbl. of net oil per day through a 5/32-in. choke, plus 95.5 per cent water. Gas-oil ratio 3,030. Production is through perforations at 5,498-5,502 ft. Top of pay is 5,490 ft., and total depth 7,485 ft. The well is approximately 1 mile west-southwest of West Sinton field, and 1¼ miles northwest of the South Sinton field. It is likely this well will be included in West Sinton field as an extension to that field.

Also in San Patricio County, A. O. Morgan 1 W. I. Thomas, dry hole south of production at West Sinton field, has been reworked and completed for an oil producer from a shallow sand. Original total depth 3,507 ft., tested salt water at 3,420-25 ft. Operators reworked, set 5½-in. casing to 2,135 ft., and perforated at 1,295-1,302 ft., and the well was completed for 65 bbl. of oil per day on pump, making 19.6°-gravity oil. This well is in Block 31, J. J. Welder subdivision, in John Pollan grant.

Sun Oil Co. 2 A. M. Albrecht, first oil producer from the Pettus zone at Boyce field, Goliad County, on potential gage flowed 77 bbl. of 45°-gravity oil per day through a 7/32-in. choke, with gas-oil ratio 800. Tubing pressure 250 psi., casing 1,000 psi., only a trace of water in the flow. Total depth is 4,272 ft., with 5½-in. casing at 4,263 ft. Production is through perforations at 4,245-50 ft. and at 4,255-64 ft. Located in Vicente Ramos grant.

Coastal Refineries & W. D. Kennard 1-B Luis Pena, wildcat in Porcion 38, 1¾ miles northwest of Sullivan City field, Starr County, is perforating for production tests. A drill-stem test at 5,763-73 ft., developed 395 psi. working pressure in 20 minutes through ¼-in. chokes, and flowed pipe line oil in 3 minutes, recovering 630 ft. of 42.5°-gravity oil, with bottom-hole pressures of 800 psi. open and 2,750 psi. closed. Previous test at 5,666-76 ft. had developed 675 psi. working pressure in 10 minutes and recovered 10 ft. of 51°-gravity condensate.

Caroline Hunt Trust Est. 1 Ernest Miller, wildcat test in southern Duval County, approximately 5½ miles southwest of Realitos, and 2½ miles north of Crestonio, is running tubing for test after setting casing for completion attempt. Total depth is 5,007 ft. This well is in the Diego Hinojosa grant, A-629.

There were 39 new locations reported this week with 12 being wildcat starts, 4 in Duval, and 2 each in Aransas and Zapata, and 1 each in Frio, Hidalgo, Jim Hogg, and Webb counties. Three successful exploratory tests were completed, 1 each in Duval, San Patricio and Webb counties. Seven wildcat failures were reported, 2 in Brooks and 1 each in Duval, Frio, Guadalupe, San Patricio and Williamson counties.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) SUCCESSFUL WILDCATS

Duval County: New gas pay North Government Wells field—Ralph E. Fair, Inc., and Jack Woodard Inc. 1 H. Wendt, in J. Poitevent Sur. 43, 2 mi. N-NW of Freer, old well drilled deeper, old TD 5,526 ft., drilled to TD 7,800 ft., top of pay 7,492 ft., Wilcox, perf. 7,492-7,540 ft., IP: 2,500,000 cu. ft. gas per day through ¼-in. choke, gas-condensate ratio 100,000, TP 1,750 psi., SIP 3,700 psi., no water. Comp. 2-26-48.

San Patricio County: New gas-condensate pay Odem field—Seaboard Oil Co. of Dela. 1 W. M. Spessard, in C. C. Hornsby Sur., 3 mi. SW of Odem, top pay 6,890 ft., TD 8,872 ft., perf. 6,890-6,900 ft., IP: 4,320,000 cu. ft. gas per day on open flow, spray of condensate, shut-in pressure 2,440 psi., no water. Comp. 2-25-48.

Webb County: New gas pool "Quien Sabe"—O. W. Killam et al 1 Marrs McLean, 6½ mi. SW of Bruni, in Block 15 of Henry James subd. out of NE part of Las Albercas grant, top pay 2,280 ft., TD 2,658 ft., perf. 2,314-16 ft. IP: 35,000,000 cu. ft. gas per day on open flow, spray of oil, shut-in pressure 535 psi., no water. Comp. 2-1-48.

SOUTHWEST TEXAS (DISTRICTS 1 AND 4) WILDCAT FAILURES

Brooks County: Continental Oil Co. 1 L. D. Miller, in Ygnacio de la Pena grant, 4 mi. S-SW of Falfurrias, 3½ mi. W-NE of Gyp Hill dome, dry, TD 10,054 ft.

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Brooks County: Humble 1 Robt. J. Kleberg, Jr., Tr., in La Noria de Tio Ayola grant, in "Los Muertos" pasture, 15 mi. S of Falfurrias and 5 mi. NE of Rachal field, dry, TD 8,499 ft.

Duval County: John F. Camp 1 Benito Alaniz, in Sandoval Sur. 10, 7 mi. E of NE/ end of Hoffman field, 2 mi. NW of Rosita, dry, TD 3,472 ft.

Frio County: W. L. Goldston 1 Ruth McLean Bowman, in Benefield and Zilker Sur. 8, 6½ mi. W-SW of Charlotte, and 1 mi. W of SW ext. area at Charlotte field, dry, TD 5,332 ft.

Guadalupe County: Humphries Branch Oil Co. 1 H. Buerger, in Humphries Branch Sur. 17, 1 mi. W of Seguin, dry, TD 1,754 ft.

San Patricio County: Luling Oil & Gas Co. 1 Fee, in Welder & Odem subd., 2⅞ mi. NE of Odem, near North Odem area, dry, TD 2,350 ft.

Williamson County: Louis Henna & Lundelius 2 W. V. Alsabrook, in David Curry Sur., 2 mi. N of Round Rock, dry, TD 2,328 ft.

OKLAHOMA

Southwest Antioch Extension Flows 84 Bbl. Per Hour

GLOBE OIL & REFINING CO. has an extension to Southwest Antioch at 1 Watson, NW SE SW 7-3n-2w, Garvin County. The well was drilled to 6,786 ft. and plugged back to 6,820 ft. Perforations were made at 6,554-58 ft. in the Gibson sand. The well flowed an average of 84 bbl. per hour for 8 hours with gas-oil ratio of 854-1.

Tide Water Associated Oil Co., on the third drill-stem test at the 1 South Marlow Unit, C SE SW 27-2n-7w, Stephens County, has gas and distillate production indicated in another section of 22 ft. Test made at 8,290-8,312 ft. recovered 990 ft. of gas and distillate-cut water load and 210 ft. of gas and condensate-cut mud. Shut-in pressure after 15 minutes was 3,750 lb. and flowing pressure was 700 lb.

Stanolind Oil & Gas Co. 1 Wildman, NW NE NE 19-19n-11w, Blaine County, topped the Wilcox sand at 9,875 ft. and on a 2-hour drill-stem test at 9,834-80 ft. recovered 90 ft. of mud with no oil, gas or water. Operator recovered hard, dry, fine sand from core of the Wilcox at 9,880-90 ft. and is coring ahead.

Stanolind Oil & Gas Co. recovered only water load and mud in a drill-stem test of the Oil Creek sand at 1 Briscoe, C NW NE 4-4n-5w, deep test in Grady County. Packer was set at 14,823 ft. and total depth of hole was 15,184 ft.

Frank B. Murta and Deep Rock Oil Corp. have extended the Prue sand production almost a mile to the east of Stroud district by production at 1 Hiett, SE SE SW 15-14n-7e in Creek County. The well flowed 125 bbl. in 10 hours after a 150-qt. shot. The Prue sand was cut at 2,750 ft. and total depth was 2,810 ft.

OKLAHOMA SUCCESSFUL WILDCATS

Osage County: Denman 2 Osage, C W/2 NE SE 33-28n-11e, pumped 40 bbl. of oil per day from Lenopah and Wayside at 986-1,005 ft.

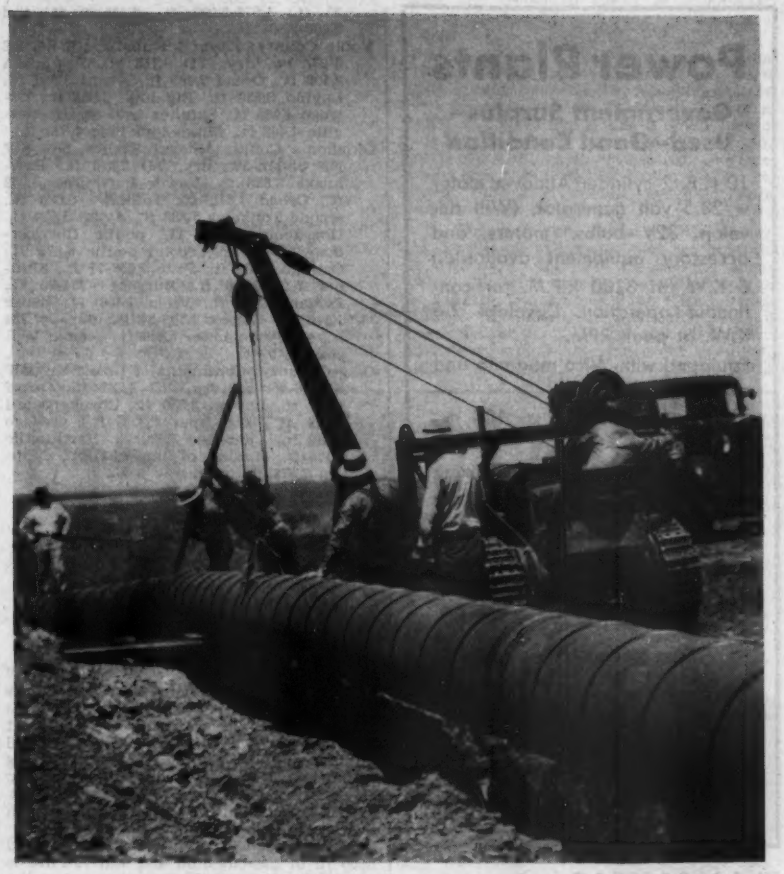
Pawnee County: New pay in Maramec—Maguire 1 Cave, SW SW NW 10-20n-6e, pumped 30 bbl. of oil per day from Bartlesville at 3,140-61 ft., TD.

Okfuskee County: Jackson 1 FcFadden, SW SW SW 26-12n-10e, pumped 60 bbl. of 38°-gravity oil per day from Cromwell at 3,128-51 ft., TD 3,173 ft.

Pontotoc County: Sohio 1 Wilfong "A," NW NE SE 34-5n-5e, pumped 98 bbl. of 39°-gravity oil per day from Viola at 2,910-44 ft., TD.

OKLAHOMA WILDCAT FAILURES

Jefferson County: Little 1 Sullivan, SE SW NW 28-3s-4w, dry, TD 2,509 ft., Loco lime 1,068 ft., second Loco lime 1,170-80 ft., sands 1,220-50 ft., 1,285-1,300 ft., 1,845-



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95 ft., 1,975-2,000 ft., 2,425-50 ft. and 2,460-2,504 ft.

Noble County: Eason 1 Kuballa, SE SE SE 3-23n-1w, dry, TD 4,713 ft., Pawhuska 2,102 ft., Oread 2,485 ft., Avant 3,189 ft., Layton 3,530 ft., Big lime 3,985 ft., Oswego 4,068 ft., Skinner 4,404 ft., Bartlesville 4,462 ft., Mississippi lime 4,620 ft.

Oklahoma County: Star 1 Socher, SW SW NE 21-11n-3w, dry, TD 7,878 ft., Pawhuska 3,826 ft., Lower Pawhuska 4,052 ft., Oread 4,875 ft., Tonkawa 5,080 ft., second Tonkawa 5,138 ft., Avant 5,620 ft., Hogshooter 6,125 ft., oolitic Checkerboard 6,490 ft., second oolitic 6,675 ft., Oswego 7,004 ft., Prue 7,058-71 ft., Skinner 7,170-7,200 ft., Burgess 7,254-95 ft., Sylvan 7,349 ft., Viola 7,466 ft., dense 7,540 ft., Wilcox 7,703-34 ft., dense 7,734 ft., sandy dolomite 7,830 ft., second Wilcox 7,845 ft.

Osage County: Continental 1 Cross, SW SW SE 18-26n-5e, dry, TD 3,732 ft., Oread 1,632 ft., Layton 2,350 ft., Checkerboard 2,712 ft., Big lime 2,830 ft., Oswego 2,949 ft., Cherokee 3,030 ft., Bartlesville 3,178 ft., Mississippi lime 3,227 ft., Simpson 3,578 ft., Arbuckle 3,682 ft.

ROCKY MOUNTAIN

Rocky Point Wildcat Gets Water in the Minnelusa

DENVER.—Water has been found in the Minnelusa section at Pure Oil Co.'s Rocky Point wildcat on the northeast side of the Powder River basin. The well is 1 Unit, NW NE NE 17-26n-86w, Campbell County, and a week ago showed staining in the Pennsylvanian prior to the test. Top of the Minnekahta was found at 5,342 ft. and Minnelusa at 5,407 ft. Cores in both sections had shown oil staining but on drill-stem test 5,432-63 ft. the operator recovered 1,900 ft. of gas-cut mud and water. Pure is now coring below 5,475 ft. and may test the Madison in this well. On drill-stem test of the Minnekahta the packer failed but a small amount of oil and gas-cut mud was recovered. This zone may be retested later. There was considerable interest in the Rocky Point wildcat because of the large leasing program carried on in the northern section of the Powder River basin following the discovery of oil at Adon, 35 miles southwest, and the shore-line play on the eastern side of the basin following development drilling at Mush Creek in Weston County. Rocky Point was drilled by Continental Oil Co. in 1940 and the well found streaks of dead oil in the Minnelusa but was a failure at 6,105 ft., total depth, in the Madison.

Thirty miles west of Casper Pure's West Poison Spider wildcat, now the deepest well ever to be drilled in the Rocky Mountains, is standing following cementing of casing at 13,791 ft. The well is 1 Unit, C NW SE 11-33n-84w, and a week ago shows of oil and gas were encountered below 13,800 ft. The operator drilled to 13,840 ft., total depth, before running casing and plug will be drilled for a test within a few days. This wildcat is based on seismic exploration by Pure in the general Basin area west of Casper.

Stanolind Oil & Gas Co. has established a new producing horizon in the Torchlight field with Well 2 Orchard Unit, SW NE SE 24-51n-93w, Big Horn County. The operator swabbed 344 bbl. of oil in 24 hours and is now installing pump. Production is from the Madison between 3,363-3,635 ft. after the well encountered water in the lower Madison at 3,800 ft., total depth. The well was acidized with 2,000 gal. prior to the test. This is the first well at Torchlight to find commercial production, although a flank well was drilled to that horizon several years ago and found water. The well is located one-half mile southwest of Stanolind's Tensleep discovery well which was completed 3 months ago. Tensleep in the present test showed 90 per

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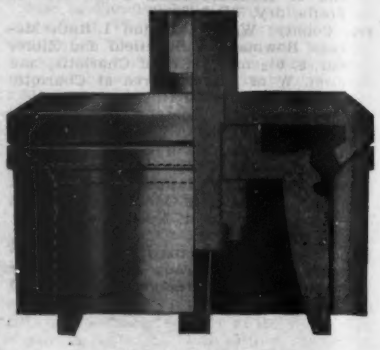

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cent water and it is indicated that the productive area for the field in the Tensleep will be small.

Byrd-Frost, Inc., Western Natural Gas and Paul B. English have abandoned the interesting wildcat at Boulder Knoll, San Juan County, Utah, after failing to find production to 8,678 ft., total depth, in the Madison. The well is 1 Redd, C SE NE 23-34s-25e, and found the following formation tops: Shinarump 2,560 ft.; Hermosa 4,346 ft.; Paradox 5,695 ft.; Molas 7,965 ft.; and Madison 8,110 ft. with elevation at 6,805 ft. Shows of gas were encountered in the Paradox and in the Molas but were noncommercial on testing. These operators are now drilling three other wildcat tests in Utah and Colorado. No information is being released now on operations at Boundary Butte, Well 1 Navajo, C NE NW 22-43s-22e, San Juan County, Utah. The well was at 6,090 ft., with no formations reported, when the operator discontinued the release of information. Other wells being drilled by the same operators are located at Dove Creek and McElmo in Montezuma County, Colorado.

New operations.—Sixteen new locations were made with eight in Montana, five in Colorado and three in Wyoming. A total of seven locations were made in the Cut Bank and Kevin-Sunburst pools. An extension test in the Utopia area was announced by The Texas Co. in Utopia field of Libesty County at 2 Fenger, C SE SW 13-33n-4e. In Wyoming Seaboard has made location for another Phosphoria test at Silver Tip at 37-28-G, NW SE SW 28-58n-100w, Park County, following the successful completion of a Phosphoria discovery a week ago. Included as a first report this week is the Western Natural Gas, Byrd-Frost, Inc., and P. B. English new operation on Stanolind's abandoned wildcat at 1 Schmidt, C SW NW 24-36n-18w, in the McElmo area, Montezuma County, Colorado. The well was drilled in 1944 and abandoned in Devonian at 7,046 ft., total depth. Western Natural et al have moved a rig from the temporarily abandoned wildcat ¼ mile north and will clean out and possibly deepen the Stanolind dry hole. Other new operations were for routine pool wells.

Completions.—A total of 17 wells were completed with 9 in Wyoming, 4 in Montana, 3 in Colorado and 1 in northern New Mexico. Total daily initial production for all completions was 2,856 bbl. of oil. In Wyoming official abandonment of two wildcats was released. Both wells were in the Lost Soldier area of Carbon and Sweetwater counties. Ohio's South O'Brien Springs wildcat was abandoned after water was found in the Sundance at 2,515 ft., total depth. On a farm-out from Carter Oil Co. the Amerada Petroleum Corp. completed its test of the Stewart Creek area at 6,006 ft., total depth, in the Fort Union. This well was of interest in the northern Red Desert Basin area. A dual completion of interest in Wyoming was Ohio's Hatfield extension test at 2 Union Pacific, C SW SE 35-20n-88w. This well was finally completed flowing 1,000 bbl. of oil with 4,000,000 cu. ft. of gas daily from the Tensleep after that formation was shot.

WYOMING WILDCAT FAILURES

Carbon County, South O'Brien Springs: Ohio 1 Johnson-Govt., SW NW NE 26-24n-88w, 2,515 ft. TD, abnd., Dakota 2,004 ft., Morrison 2,111 ft., Sundance 271 ft., sand 2,426 ft., water, elev. 6,488 ft. RT.

Sweetwater County, Stewart Creek: Carter-Amerada 1 Floyd C. Ruddy, C SW NW 14-24n-90w, 6,006 ft. TD, abnd., Fort Union 4,310 ft., elev. 7,095 ft. DF.

COLORADO WILDCAT FAILURES

Montezuma County, Mancos Area: M. T. Anderson & Randall 1 Fee, C NE NW 14-35n-14w, 1,334 ft. TD, abnd., Dakota 860, Morrison 902, elev. 6,570 ft.

Montezuma County, McElmo Area: Byrd-Frost, Western Natural, and Paul B. English 1 MacIntosh, C NW NW 25-36n-18w, 4,965 ft. TD, temp. abnd. Shinarump 1,530 ft., Rico 3,360 ft., Hermosa 3,550 ft., Paradox 4,455 ft., Anhydrite 4,510 ft., Igneous 4,610 ft., elev. 5,027 ft. DF.

LA.-ARK.

Several Tests Nearing Interesting Stages

SHREVEPORT.—Union Producing Co. and Pure Oil Co.'s 1 Nebo Oil Co., Bienville Parish test in 30-14n-5w, was well below the old total depth of 7,784 ft., but had no shows in drilling below 7,917 ft. in sand and shale. Operators reported a drilling break at 7,820-25 ft., and at 7,867 ft. stopped for a 16-minute drill-stem test between 7,819-67 ft. When opened, it produced a very slight blow and recovered 350 ft. of muddy salt water. Bottom-hole flowing pressure was 435 psi.

Hassie Hunt et al 1 G. W. James, Cotton Valley test 4½ miles north of the North Lisbon field, in 10-22n-4w, reported corrected total depth at 11,007 ft. in salt, topped at 10,987 ft. Elevation is 129 ft. Two feet of salt was recovered in coring between 10,969-11,007 ft. Electric log was run and sidewall cores taken in the Cotton Valley between 9,737-48 ft., which recovered white sand with no shows.

In Lincoln Parish, Carter Oil Co. 1 Martin Matthews, 22-18n-4w, gave up attempts to drill-stem test, and was drilling ahead below 9,191 ft. in the Cotton Valley, topped at 9,082 ft., by samples. Five tests between 9,026-46 ft. failed, mechanically. Testing continued at W. C. Feazel 1 C. C. Barham, 21-20n-3w, which has shown for gas-distillation production. An acid treatment at

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8,798-8,818 ft., in the Cotton Valley, produced a flow of acid water, and very little gas. A second treatment increased gas to 600,000 cu. ft. a day, through 3/16-in. choke, plus an estimated 40 bbl. of distillate. Tubing pressure was 1,300 psi., and shut-in pressure 2,550 psi. Retainer was set at 8,550 ft. and new perforations made between 8,510-30 ft., in the Bodcaw.

In Natchitoches Parish, Continental Oil Co. 1 Pardee Co., 30-12n-6w, was drilling in lime and shale at 9,062 ft. It had Travis Peak at 8,056 ft., by samples. In Union Parish, C. M. Bagley et al 1 T. W. Auger, 36-23n-1w, 3 miles north of the Ora field, had total depth at 2,290 ft. Cores at 2,191-2,204 ft. recovered 11 ft., being 5 ft. of slightly saturated sand, 2 ft. of shale, and 4 ft. of ashy sand with fair odor. Operators ran electrical survey and shut down for orders. Tentative identity of the sand is the Nacatoch.

Hunt Oil Co. 1 A. C. Burns, 16-23n-9w, Webster Parish, was drilling at 7,554 ft., with no details available. Shell Oil Co., Inc., 1 Frost Lumber, 15-22n-1e, Union Parish, was shut down for repairs at 8,710 ft. Pan-American Producing Co. 1 J. H. Albritton, 10-19n-1e, Union Parish, was drilling below 4,741 ft. M. T. Halbouth and Stanolind Oil & Gas Co. 1 Bolinger-Boyd, 30-23n-12w, Bossier Parish, was drilling at 4,880 ft. in lime and shale.

Arkansas operations included Robert W. O'Mears et al 1 Moody, 12-16s-22w, Columbia County, which perforated at 7,228-32 ft., but tested salt water. It was to be tested 100 ft. higher. Caddo Oil Co., Inc., 1 G. H. Christopher, 9-11s-22w, Nevada County, was drilling in Eagle Mills at 5,205 ft. Sohio Petroleum Co. 1-B Annie Smith, discovery offset in 8-16s-17w, Union County, had no shows in drilling at 4,385 ft.

NORTH LOUISIANA WILDCAT FAILURE

Union Parish: J. H. Stone 1 O. B. Lee, SE SE NW 20-21n-1w, dry, TD 2,501 ft., Nacatoch 2,128 ft., Saratoga 2,263 ft., Meakin 2,466 ft., elev. 204 ft.

PERMIAN BASIN

Upton Discovery Prospect To Get Second Test

MIDLAND.—Wilshire Oil Co. 1 McElroy Ranch, Upton County discovery prospect in what has tentatively been called the Wolfcamp, deepened 50 ft. to 8,054 ft. and prepared for a second drill-stem test. The first test, from 7,922-8,004 ft., produced a strong blow of air as soon as the tool was opened. Gas showed at the top in 31 minutes, reaching an estimated volume of 200,000 cu. ft. per day. Operators then pulled 63 strands of pipe, when it started unloading oil, recovering a total of some 2,000 ft. of mud-cut oil and 210 ft. of water having traces of salt water. There was no sulfur content. Shakeout tests showed the chloride content to be 10,000 parts per 1,000,000.

The 1 McElroy Ranch is Wilshire's first operation in the Permian Basin. Location is 660 ft. from north and east lines of the SW Section 148, Block E, CCSD&RGNG Survey, and approximately 5 miles east of the shallow McElroy field. It is contracted to the Ellenburger, which is expected around 13,000 ft.

In Andrews County, Phillips Petroleum Co. 5-M University, Section 31, Block 13, University Lands, and approximately 2 miles southwest of the Fullerton Ellenburger discovery, was shut in after flowing 1,854 bbl. of oil in 23 hours. First called an extension well, operators are now said to be asking for discovery allowable and new field designation. The well kicked off while swabbing and was allowed to flow into pits for 2 hours to clean. Flowing through ½-in. choke, it gaged 1,270 bbl. of oil in 16 hours, and 584 bbl. of oil the following 7 hours. The oil is coming from perforations between 10,590-640 ft. On last report it was shut in for potential tests.

Phillips 1-T Texas University, 1 mile south of the Devonian discovery in the Shafter Lake field, 1,980 ft. from south and west lines of Section 36, Block 13, University Survey, was drilling below 10,578 ft. in the Devonian limestone. It has shown very small amounts of oil, along with some sulfur water, in the Devonian. Operators were to carry it on to the Fusselman, expected around 10,800 ft.

Stanolind Oil & Gas Co. 1 E. C. Nix, 2½ miles south of the Fullerton area, ran electrical survey after finding water in the Ellenburger. A 90-minute drill-stem test from 11,499-532 ft. recovered 2,600 ft. of water blanket, 180 ft. of drilling mud, 90 ft. of mud-cut water and over 8,000 ft. of sulfur water. There were no shows of oil or gas. The 1 Nix is in the SW NE Section 21, Block A-47, PSL Survey.

McAlester Fuel Co. 1 M. M. Fisher, wildcat in Section 36, Block 13, 4½ miles northeast of the Shafter Lake Wolfcamp and Devonian area, was drilling below 10,065 ft. in Mississippi limestone, topped at 9,836 ft. Elevation is 3,136 ft. Two miles east of the Shafter Lake field, Sinclair Prairie Oil Co. 1 John M. Stevenson, Section 13, Block A-36, was drilling ahead after setting surface casing.

In Pecos County, R. R. Herrell et al 1 W. C. Jackson, shallow prospect 1 mile northwest of the Pecos Valley low gravity field, in Section 102, Block 8, H&GN Survey, deepened from 1,790 to 1,823 ft. in the Yates sand and shot with nitro between 1,790-1,815 ft. After shooting it kicked off and flowed by heads for 30 minutes, then flowed steadily for 90 minutes. Two 24-hour tests produced 75 and 50 bbl. of oil, respectively.

C. W. Chancellor and Slick Oil Co. 1 Davis, gas-distillate discovery 2 miles west of the Pecos Valley high-gravity area, continued testing through perforations in the

Ellenburger from 9,125-9,580 ft. Last report estimated the gas flow to be from 4,000,000 to 5,000,000 cu. ft. daily, with a good spray of distillate and a small amount of wash water, flowing through ⅜-in. choke.

West Texas fields gained 42 new operations last week, and 10 wildcats. Counties listing new exploratory tests were: Gaines 2, Upton 2, and 1 each in Andrews, Culberson, Ector, Terrell, Tom Green and Ward. In field locations, Hockley led with 13 starts, followed by: Gaines 6, Ector 4, Scurry 3, Winkler 3, Crane 3, Andrews 2, and 1 each in Dawson, Reagan, Reeves and Runnels counties. Completions for the week were 61 oil wells, 2 gas and 6 dry holes, including 2 dry wildcats.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Pecos County: Standard Oil Co. of Texas 1 Ethel M. Wick, Sec. 109, Blk. 8, H&GN Sur., 9 mi. S Grand Falls, dry, TD 613 ft. in shale.

Regan County: H. L. Hunt & Moore Exploration Co., Inc., 1-E.A. University-Standard, Sec. 14, Blk. 12, University Lands, 7 mi. SW Big Lake, dry, TD 10,019 ft., Permian 850 ft. Yates 1,480 ft., San Andres 2,390 ft., Devonian 9,270 ft., Ellenburger 9,778 ft., elevation 2,719 ft., oil and gas-cut mud at 9,205-58 ft., gas-cut mud 9,620-9,788 ft., and sulfur water from DST 9,897-10,019 ft.

SOUTHEASTERN NEW MEXICO

HOBBS.—Humble Oil & Refining Co. this week announced location for its 8,000-ft. Chavez County wildcat, which is slated for immediate drilling. The Ellenburger test is to be the 1-U State in the SW SE 10-12s-27e, approximately 5 miles southeast of Bottomless Lakes and 15 miles southeast of Roswell.

In the Monument area of Lea County, Barnsdall Oil Co. 9 Alaska Cooper, 12-20s-36e, perforated casing in the Drinkard zone of the lower Permian at 6,806-56 ft. and swabbing developed a hole full of water, with no shows of oil or gas. Holes were to be squeezed and new perforations made between 5,250-65 ft., in the Glorietta, where possibilities of production were shown while drilling.

Amerada Petroleum Corp. 2 H. S. Record, 25-19s-35e, was below 12,823 ft. Mid-Continent Petroleum Corp. 1-A Sawyer, 27-9s-36e, was below 11,753 ft. in dry limestone. Euromex Oil Co., Inc. 1 Andrus, 14-16s-36e, recovered lost bit cones and was drilling ahead below 5,350 ft. in limestone. Mesa Retailers, Inc. 1 Blindsnake, north Eddy County test in 2-16s-25e, was ready to resume work after fishing tools blown up the hole by a sudden encounter with gas.

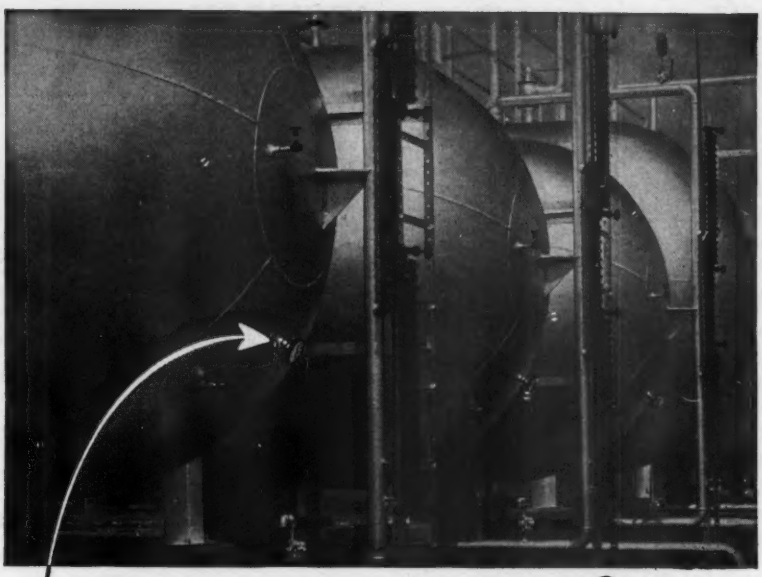
KANSAS

New Pool for Northeastern McPherson County

DON INGLING et al 1 Miller, SE SE NW 1-18s-2w, McPherson County wildcat, appears to be the opener for a new area about a mile west of Hoffsommer pool. The Mississippian was topped at 2,842 ft. and the plug drilled to 2,851 ft. On the latest reported test the well swabbed 25 bbl. of oil per hour for 6 hours.

In Rooks County Cities Service Oil Co. has again extended Zurich Townsite pool by production at 1 Mongeau, NE SE NW 27-9s-19w. Production is from the Arbuckle, cut at 3,614 ft. with casing set to 3,619 ft. On early tests before acidizing the well pumped 229 bbl. in 12 hours, and after acid treatment has been assigned a potential of 1,480 bbl. per day.

Farther west in Rooks County, Virginia Drilling Co. has a good show at 1 Rathbun, SE SE NE 27-9s-20w, northwest offset to the discovery well of Northampton pool. At



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3,806 ft., or 4 ft. in the Arbuckle, 1,480 ft. of oil rose in the hole in 10 minutes.

A northeast extension to Boggs pool in Barber County appears to be in the making from the show at Magnolia Petroleum Co. 1 Boggs, SW SW SW 9-33s-12w. A 30-minute drill-stem test of the Simpson, 4,863-73 ft., flowed gas in 1 minute and recovered 260 ft. of oil.

For the week 31 new locations were recorded: Barton County leading with a total of 10, Russell County with 5, Butler County with 3, Ellis and Sedgwick counties with 2 each.

KANSAS WILDCAT FAILURE

Stafford County: Shields & Armer 1 Dole, SW NW SE 3-23s-12w, dry, TD 3,820 ft., Heebner 3,145 ft., Lansing 3,304 ft., show of oil 3,316-84 ft., Basal Kansas City 3,556 ft., Viola 3,639 ft., Arbuckle 3,768 ft.

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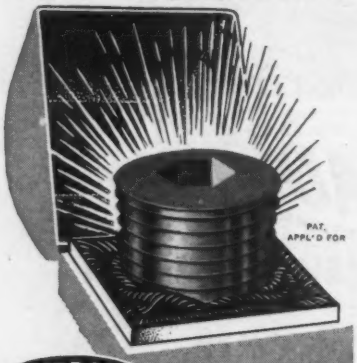

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MICHIGAN

Six Completions Produce Total of 148 Bbl. Daily

SAGINAW.—Initial daily potential totaled 148 bbl. a day from the six oil producers completed last week in Michigan. Field operations included completion of four wells as dry holes, three being wildcats, while 11 new locations were reported. Three producers, 15, 25 and 38 bbl., were completed in Bay County. An Arenac Deep River field completion produced 35 bbl. daily; an Arbela field well in Tuscola County 30 bbl. a day; and a Barry County well 5 bbl.

Three of the new locations are in Allegan County, two in Berrien, two in Bay. One each is listed in Arenac, Livingston, Isabella and Clinton counties.

MICHIGAN WILDCAT FAILURES

Allegan County, Overisel Township: Ford Oil Co. 1 John Dozeman, NE NW SE 12-4n-14w; dry in Traverse limestone; TD 1,642 ft.

Ionia County, North Plains Township: T. F. Caldwell and C. L. Maguire, Inc., 1 Thomas and Lillian E. Donahue, NE SE SE 4-8n-5w, dry in Dundee, TD 3,120 ft.

Muskegon County, Blue Lake Township: Muskegon Oil Corp. 1 Margaret M. Wolf, SW SE SW 34-12n-16w, dry in Traverse limestone, TD 1,923 ft.

OHIO, KENTUCKY

Mid East Well Makes 17 Bbl. Daily

COLUMBUS.—Mid East Oil Co. found 500,000 cu. ft. of gas and an oil showing in the Ohio shale while drilling for the Medina sand on J. M. Beaschler, Section 15, Salt Creek Township, Muskingum County. The gas was exhausted, but the well has been making 17 bbl. a day and will be completed at this depth.

The Foraker Drilling 1 Ada L. Thompson, Section 34, York Township, Morgan County, extended the Tropic pool ½ mile to the south. The Clinton and Medina sands showed 200,000 cu. ft. natural and held up well at 300,000 cu. ft. after shot. A southeast offset is planned.

The Ohio Fuel 1 Carnes-Derr, Lot 18, Linton Township, Coshocton County, was drilled in with 12 ft. of hard Oriskany sand. The natural production was 281,000 cu. ft. and 490,000 cu. ft. after shot. An offset ½ mile to the west will be drilled.

Fred Beasley 1 Lola Coulter, Section 27, Bearfield Township, Perry County, gaged 150,000 cu. ft. from the Clinton at 3,855-95 ft., and 400,000 cu. ft. from the Medina at 3,978-84 ft. When shut in after shot, the gage was 750,000 cu. ft. In Madison Township the Mid East Oil 2 Francis Love, Section 15, further extended the Sego pool with a combination well. Clinton sand at 3,354-3,412 ft. made 22 bbl. and 400,000 cu. ft. after shot.

Quaker State Oil Co. is moving in to drill a wildcat Oriskany sand test on John Hayman, Section 5, Letart Township, Meigs County.

Fourteen locations in nine counties were reported for the week. Lorain County had three, and Tuscarawas, Perry and Morgan two each. Thirty-three wells were completed with Lancaster having seven.

OHIO SUCCESSFUL WILDCATS

Summit County, Stow Township: East Ohio Gas Co. 1 C. Kirkhart, Lot 72, Clinton 3,762-3,840 ft., 90,000 cu. ft., TD 3,943 ft.

WESTERN KENTUCKY

OWENSBORO.—Sun Oil Co. 1 Lilly Binford, SW NE SE 23-O-19, Union County is to go on pump to test Pennsylvania sand show at 1,403-19 ft. Well is about 3 miles west of Morganfield, Ky., and about 2 miles south of the Morganfield pool.

In McLean County Miller & Shiarella and Ashland Oil & Refing Co. 4 F. G. Robertson, SW NW SE 13-N-27, has been completed with an initial production of 150 bbl. per day from the Cypress sand at 1,949-76 ft. after a shot of 120 qt. Total depth is

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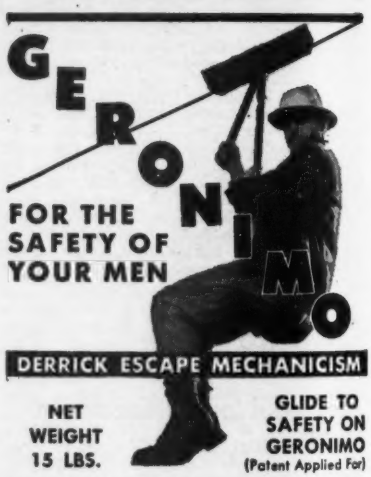

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2,056 ft. and was plugged back to 2,005 ft.

In Union County the wildcat George S. Engle 1 L. O. Alvey, 25-P-19, 4 miles west of the Uniontown pool, is drilling below 2,497 ft.

EASTERN KENTUCKY

ASHLAND.—Two completions were noted in the Eastern Kentucky field of operations during the week. Kentucky West Virginia Gas Co. completed well No. 883, James M. Billiter, Pike County, at 3,995 ft., 400,000 cu. ft.

Kentucky West Virginia Gas Co. completed well No. 5,763, Wilson Triplett, Knott County, at 3,143 ft., 215,000 cu. ft.

INDIANA

EVANSVILLE.—George S. Engle has good prospects for a new pay in Belknap pool at 1 P. Kerossel, NW SW NW 17-6s-11w, Vanderburgh County. On a drill-stem test for 1 hour at 1,912-15 ft., Tar Springs sand, operator recovered 6 ft. of oil and 50 ft. of oil-cut mud with no water. Casing has been set at 1,912 ft.

In the area northeast of the Martin pool in Vanderburgh County, Illinois Mid-Continent Co., J. A. Rose, D. L. Jobe, and Milt Lobree 1 Leo Schmitt, NE NE NW 30-4s-11w, is a wildcat that is attracting considerable attention in the area. The well had a show of oil in the Cypress sand at 2,228-40 ft. and is now drilling below 2,500 ft. with a test of the St. Louis limestone as the objective unless commercial production is found at shallower depths.

ILLINOIS

Franklin County Has Good Aux Vases Producer

MATTOON.—In the area at the north of the Thompsonville, North pool, George & Wrather, E. T. Wix, and Indiana Farm Bureau had an excellent show on a drill-stem test of Aux Vases sand at 1 Galbraith, SE SE SW 10-7s-4e, Franklin County. Operator got gas in 8 minutes and at the end of the 1-hour test recovered 2,430 ft. of clean oil with no water. Producing zone is at 3,114-27 ft. and total depth 3,127 ft. Well has prospects for one of the best producers in the area.

In Wabash County, George & Wrather and Brubeck & Pappas 1 Galbraith, NE SW NE 14-1s-13w, had 600 ft. of gas and 110 ft. of oil with 40 ft. of oil-cut mud in a drill-stem test of the lower Cypress sand at 2,224-58 ft. Test was for 1 hour. Well is located 1 mile from other Cypress production in an area west of Mount Carmel, Ill.

William Bell 1 Raymond Sledge, NE NE NW 20-1s-4e, Jefferson County, has been completed with an initial production of 113 bbl. per day from the McClosky at 2,723-28 ft. after acidizing. Total depth was 2,810 ft.

ILLINOIS WILDCAT FAILURES

Coles County: Earl Landon 1 Beard Brothers, SE SW NE 6-13n-8e, dry, TD 423 ft.

Montgomery County: F. W. & B. C. Parker 1 Wood, SW SE SW 32-11n-5w, dry, TD 710 ft.

Jasper County: Cummings Oil Co. 1 C. Bailey, NW NW SW 5-7n-14w, dry, TD 2,471 ft.

Edwards County: Don Baines and Joe Linzy 1 C. R. Seals, SE SE NW 21-1n-14w, dry, TD 3,145 ft.

Washington County: Inland Oil Co. 1 Mentemeyer, SE SW NW 15-1s-3w, dry, TD 1,500 ft.

Perry County: Paul Doran 1 Bronke, SE SE NW 11-4s-2w, dry, TD 1,493 ft.

Papers on Production Highlight A. P. I. Meeting

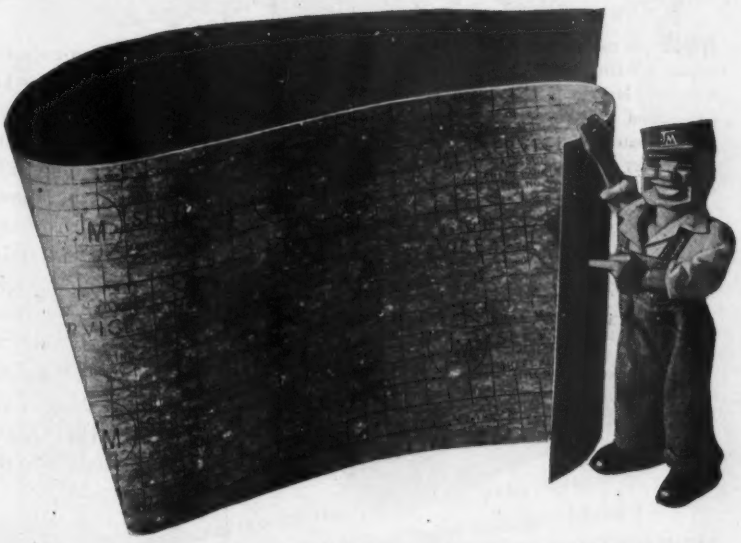
(Continued from page 103)

vantages for a definite training program: (1) "We can develop as great a capacity for engineering work in the 1 year formal training period as can be developed in 2 or 3 years by the old methods." (2) "The apprentice engineer maintains a firm grasp of his engineering fundamentals and the engineering viewpoint to the end of the training period instead of tending toward operations due to too long an exposure to purely operating jobs."

Two of the four production-practices papers were concerned with detailed engineering problems relative to pumping equipment. J. C. Slonneger, Continental Supply Co., Dallas, discussed "Desirable Characteristics and Design of Oil Well Pumping Units and Engines." The other paper, "Calculation of Peak Crankshaft Torque from Dynamometer Cards," was prepared by Harold S. Kelly, M. H. Halderson, P. A. Witherspoon, and E. S. Calvert, all of Phillips Petroleum Co.

Slonneger emphasized standardization as applied to pumping units and engines by saying: "Standardization has many desirable advantages, but

It's called SERVICE SHEET



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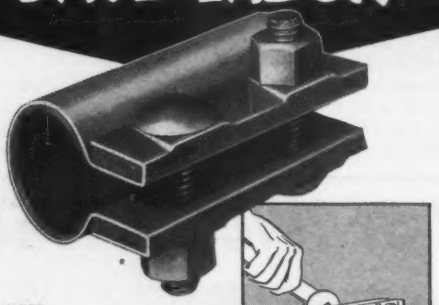

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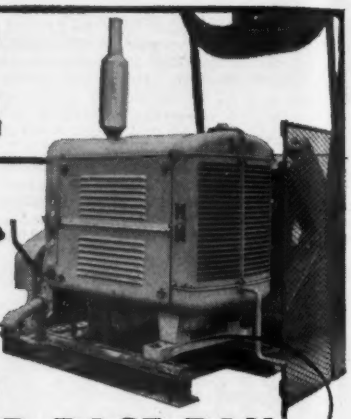

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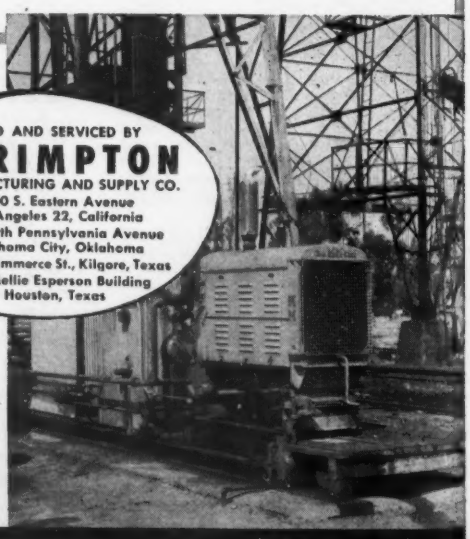

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it also has its limitation. It is sometimes difficult to decide where standardization should stop and where the ingenuity of the designer should be given its full scope. To much standardization halts progress, and brings on decay, whereas too little standardization breeds chaos."

The four Phillips engineers presented the results of a torque study made from data obtained in 1940 in an extensive series of beam pumping tests in Oklahoma City field. It was concluded that there are many pumping units in operation where peak crankshaft torque cannot be determined with acceptable accuracy, and that the oil industry needs a simpler and more economical means of obtaining peak crankshaft torque.

Mobile radio telephone service, which recently has been established in many cities, was described in detail by R. S. Johnson, Southwestern Bell Telephone Co., Kansas City, Mo.

Tax Benefits Sought for Synthetic Fuel Materials

WASHINGTON.—Congressional interest in the development of a synthetic fuels industry was manifested last week in legislation introduced in Senate and House.

Under a bill fathered by Sen. Joseph C. O'Mahoney of Wyoming the 27½-per cent depletion allowance now provided for oil production would be extended to oil shale, coal, and natural gas produced for the manufacture of synthetic fuel. Another O'Mahoney bill would amend the internal revenue code to permit the amortization of the cost of synthetic liquid-fuel plants for tax purposes over a period of 60 months.

O'Mahoney sought to have these changes incorporated in the tax-reduction bill when it came up in the Senate, but his amendments were defeated.

On the House side, Congressman Francis Case of South Dakota is sponsoring a bill providing for quick amortization and percentage depletion for materials used in the production of synthetic fuels.

Half of Oil Producers Paid No Taxes in 1945

WASHINGTON.—Income and excess profits taxes of $31,296,000 and dividends of $44,483,000 were paid on the net income of $85,887,000 reported for 1945 by 1,722 corporations engaged in the production of crude petroleum and natural gas, it was reported last week by the Treasury Department. The total receipts of these corporations were $699,821,000.

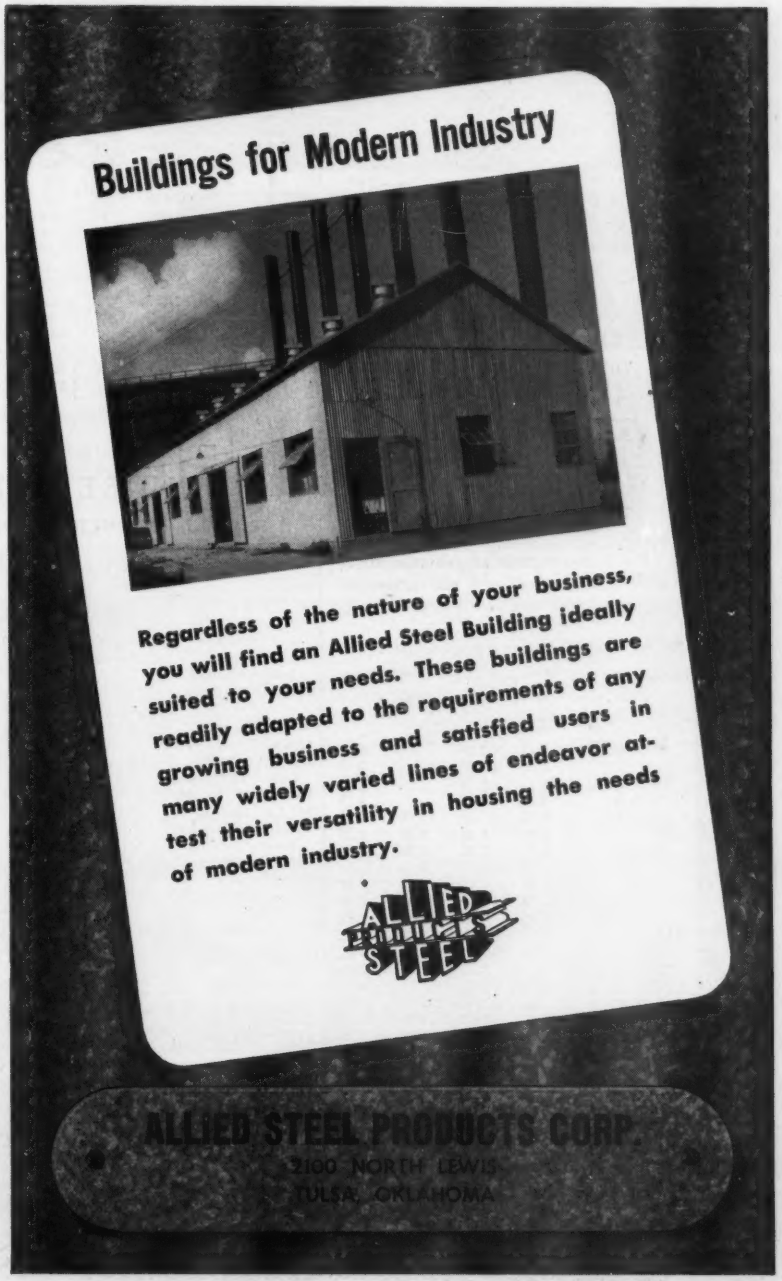
A total of 3,559 oil and gas producing corporations filed returns, but 250 of them were inactive and another 1,587, with total receipts of $224,559,000, showed a deficit for tax purposes of $26,753,000. These corporations, however, paid dividends of $9,157,000.

Consolidated returns were filed by 34 parent corporations, 23 of which, with 54 subsidiaries, reported total receipts of $143,559,000, net income of $19,321,000, total taxes of $5,917,000 and dividends of $9,016. The other eleven, with 52 subsidiaries, reported total receipts of $21,715,000, but a deficit for tax purposes of $1,869,000, and paid dividends of $676,000.

A total of 452,700 corporations of all types filed returns for 1945. Of this number, 301,259 showed a net income of $22,165,385,000 on which taxes amounted to $10,793,110,000, a decrease of 27 per cent as compared with the total for 1944. Total receipts of all active corporations were $255,318,339,000.

Oil Shows Reported

Oil shows near the village of Aisch, about 20 km. (about 12 miles) from Bamberg in the U. S. zone, according to the German news agency DPD. Tests may be made shortly.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STATISTICS and

WEEKLY WELL COMPLETIONS . . . WEEK ENDED MARCH 27, 1948

	Total of all wells					Cum.		Wildcat completions and discoveries					Cumulative total, 1948				
	Comp.	Oil	Gas	Dry	Footage	1948	1947	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	27	13	0	*14	30,048	372	337	0	0	0	0	0	0	0	0	0	0
Pennsylvania	46	22	2	†22	90,981	682	774	0	0	0	0	0	0	0	4	10	14
West Virginia	16	2	10	4	40,998	175	207	0	0	1	1	2	2	0	14	18	34
Ohio	33	9	11	‡13	96,362	286	293	0	0	1	0	1	1	0	4	8	13
Indiana	19	5	5	9	27,705	215	120	0	0	0	0	0	2	0	0	2	4
Kentucky	10	2	2	6	17,907	145	106	0	0	0	0	0	1	0	0	3	4
Illinois	26	11	0	15	56,094	467	434	0	0	0	6	6	10	0	0	78	88
Michigan	10	6	0	4	24,604	161	151	0	0	0	3	3	5	0	4	64	73
Kansas	15	10	4	1	50,003	616	617	0	0	0	1	1	8	0	1	75	84
Neb., Mo., Iowa	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Oklahoma	46	30	2	14	161,791	863	991	4	0	0	4	8	32	3	6	142	183
Texas	194	135	14	45	902,999	2,445	1,970	3	1	5	26	35	72	7	25	437	541
North Central (Dist. 7-B & 9)	45	25	2	18	137,960	721	600	2	0	1	9	12	30	0	5	139	174
West (Dist. 7-C & 8)	69	61	2	6	315,766	671	480	0	0	0	2	2	10	0	1	43	54
Panhandle (Dist. 10)	12	10	2	0	34,856	133	113	0	0	0	0	0	0	0	1	3	4
Eastern (Dist. 5 & 6)	6	2	1	3	34,920	123	110	0	0	0	2	2	3	0	0	35	38
Gulf Coast (Dist. 2 & 3)	23	14	2	7	173,041	393	385	1	1	1	6	9	20	6	5	104	135
Southwest (Dist. 1 & 4)	39	23	5	11	206,456	404	282	0	0	3	7	10	9	1	13	113	136
Louisiana	35	27	1	7	160,961	433	269	0	1	0	1	2	7	5	1	42	55
Northern	25	21	1	3	58,842	279	131	0	0	0	1	1	0	0	0	21	21
Southern	10	6	0	4	102,119	154	138	0	1	0	0	1	7	5	1	21	34
Arkansas	1	1	0	0	7,402	76	54	0	0	0	0	0	2	0	0	20	22
Mississippi	6	4	0	2	44,544	96	82	0	0	3	4	7	2	0	3	23	28
Southeastern States	0	0	0	0	0	9	13	0	0	0	0	0	0	0	0	8	8
Montana	4	4	0	0	13,330	60	39	0	0	0	0	0	1	0	0	7	8
Wyoming	9	5	0	4	44,491	91	53	0	0	0	2	2	5	0	0	11	16
Colorado-Utah	3	1	0	2	12,777	63	39	0	0	0	2	2	0	0	0	11	11
New Mexico	10	8	0	2	37,507	147	126	0	0	0	0	0	2	1	0	8	11
California	45	41	0	4	164,141	634	448	0	0	0	3	3	5	0	0	64	69
Total United States	555	336	51	168	1,984,645	8,036	7,125	7	2	10	53	72	157	16	62	1,031	1,266
Total previous week	587	345	41	201	2,060,456	7,481	6,578	7	1	3	79	90	150	14	52	978	1,194
Total March 29, 1947	568	311	55	202	1,944,277			9	2	3	65	79	148	19	35	897	1,099

Service wells included: *14, †22, ‡3.

CRUDE PRICES AND REFINERY ACTIVITY

GRAVITY SCHEDULES

Top prices include all gravities above grades designated, and low prices include all gravities below grades designated:

Gravity—	Signal Hill, Calif.	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$2.17	....	....	....
19-19.9	2.19	....	....	....
20-20.9	2.21	$2.25	....	$2.12
21-21.9	2.23	2.27	....	2.14
22-22.9	2.27	2.29	....	2.16
23-23.9	2.30	2.31	....	2.18
24-24.9	2.34	2.33	$2.06	2.20
25-25.9	2.38	2.35	2.08	2.22
26-26.9	2.41	2.37	2.09	2.24
27-27.9	2.45	2.39	2.62	2.26
28-28.9	2.49	2.41	2.64	2.28
29-29.9	2.52	2.43	2.66	2.30
30-30.9	2.56	2.45	2.68	2.32
31-31.9	2.59	2.47	2.70	2.34
32-32.9	2.62	2.49	2.72	2.36
33-33.9	....	2.51	2.74	2.38
34-34.9	....	2.53	2.76	2.40
35-35.9	....	2.55	2.78	2.42
36-36.9	....	2.57	2.80	2.44
37-37.9	....	2.59	2.82	2.46
38-38.9	....	2.61	2.84	2.48
39-39.9	....	2.63	2.86	2.50
40 and above	....	2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point. †Includes Lea County, New Mexico.

A.P.I. REFINERY REPORT, WEEK ENDED MARCH 20

(Thousands of barrels)

District—	Crude runs, daily avg.	Production: Gasoline†	Kerosine	Gas & dist. oil	Residual	Stocks at refineries, bulk terminals, in transit and in pipe lines: Gasoline*	Kerosine	Gas & dist. oil	Residual
East Coast	831	2,045	359	1,351	1,695	22,809	3,519	6,992	6,997
Appalachian:									
District 1	101	306	61	98	83	2,211	155	292	312
District 2	75	223	31	73	121	1,049	105	175	105
Ind., Ill., Ky.	871	2,806	485	946	1,133	21,640	1,723	3,551	3,197
Okla., Kans., Mo.	409	1,400	196	499	494	11,043	444	1,651	1,374
Inland Texas	258	1,049	118	203	416	4,327	254	288	791
Texas Gulf Coast	1,281	3,623	624	2,263	1,720	20,343	1,144	4,236	5,215
La. Gulf Coast	439	1,217	398	719	578	6,079	1,051	2,089	1,840
N. La. and Ark.	76	163	59	90	126	2,252	337	317	195
Rocky Mountain:									
New Mexico	9	22	4	7	22	96	25	17	28
Other Rocky Mtn.	155	433	37	182	290	3,299	98	672	660
California	839	2,293	159	1,041	2,328	18,099	1,093	10,443	26,889
March 20, 1948	5,344	15,600	2,531	7,472	9,006	113,247	9,948	30,723	47,603
March 13, 1948	5,407	15,608	2,547	7,754	9,292	111,918	9,677	32,108	48,546
March 22, 1947	4,830	14,309	2,089	5,687	8,545	104,609	10,095	31,872	42,380

*Finished and unfinished. †At refineries including natural blended.

Bureau of Mines crude-oil stocks 220,971,000 bbl. as of March 20—up 1,258,000 bbl. One year ago 225,720,000 bbl.

FLAT CRUDE PRICES

Representative posted schedules per bbl.

East Texas	$2.65
Kettleman Hills, California*	2.14
Beauregard Parish	2.60
Illinois Basin	2.77
Pecos County, Texas (Yates)	2.35
Bradford, Pennsylvania	5.00
Eastern Ill. and Western Ind.†	2.77
Tomball, Texas Gulf Coast	2.83

*37°-37.9°. †35° and above.

TRENDS

DAILY AVERAGE PRODUCTION FOR WEEK

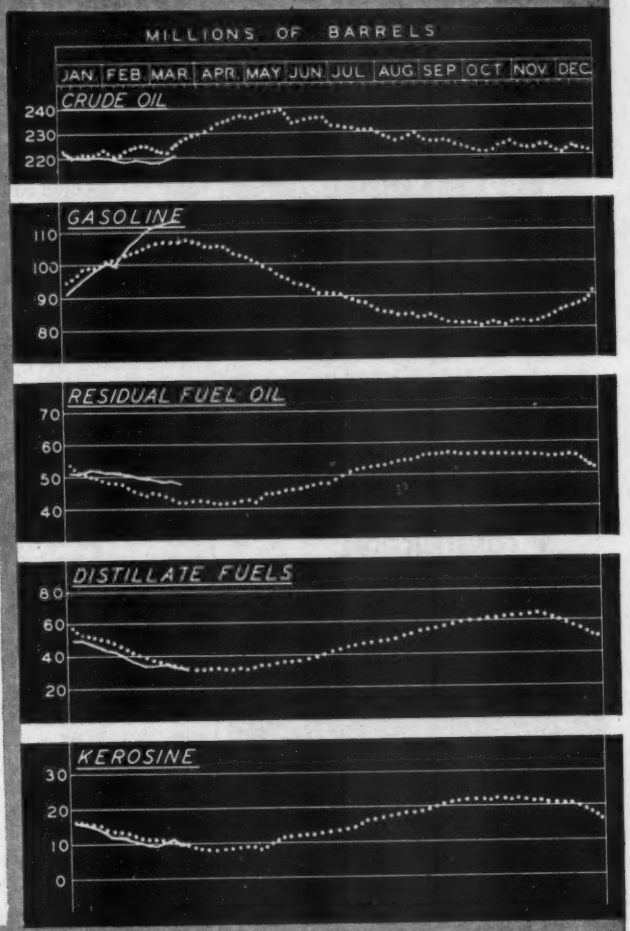
	Mar. 27 crude oil	B. of M. Mar. demand	Mar. 20 crude oil
Alabama	1,500	1,500	1,350
Arkansas	85,500	83,000	87,450
California	945,800	930,000	946,700
Colorado	46,040	48,000	46,700
Eastern	65,200	64,900	64,800
Florida	825	1,000	850
Illinois	169,700	180,000	168,700
Indiana	18,700	16,000	17,000
Kansas	300,000	304,000	171,350
Kentucky	24,700	26,000	24,400
Louisiana	475,050	474,000	476,150
North Louisiana	121,400	.....	122,500
South Louisiana	353,650	.....	353,650
Michigan	48,600	46,000	45,700
Mississippi	120,060	116,000	119,260
Montana	24,100	24,000	24,120
Nebraska	450	600	450
New Mexico	128,950	128,000	128,950
Oklahoma	400,700	410,000	395,750
Texas	2,400,675	2,400,000	2,400,675
Dist. 1 (Southwest)	25,475	.....	25,475
Dist. 2 (Southwest)	170,350	.....	170,350
Dist. 3 (Gulf Coast)	491,350	.....	491,350
Dist. 4 (Southwest)	253,200	.....	253,200
Dist. 5 (Eastern)	43,350	.....	43,350
Dist. 6 (Eastern)	121,225	.....	121,225
East Texas field	323,000	.....	323,000
Dist. 7-C (West)	43,850	.....	43,850
Dist. 8 (West)	666,700	.....	666,700
Dist. 7-B (W. Central)	43,100	.....	43,100
Dist. 9 (N. Central)	135,675	.....	135,675
Dist. 10 (Panhandle)	83,400	.....	83,400
Wyoming	141,940	137,000	142,050
Total United States	*5,398,490	5,390,000	5,262,405
Change from prev. wk., up	136,085		

Total production January 1-March 27 .... †469,801,850 bbl.
Same period last year (crude plus cond.).. 411,089,520 bbl.

*Not incl. 54,410 bbl. condensate. †Incl. 4,420,085 bbl. condensate.

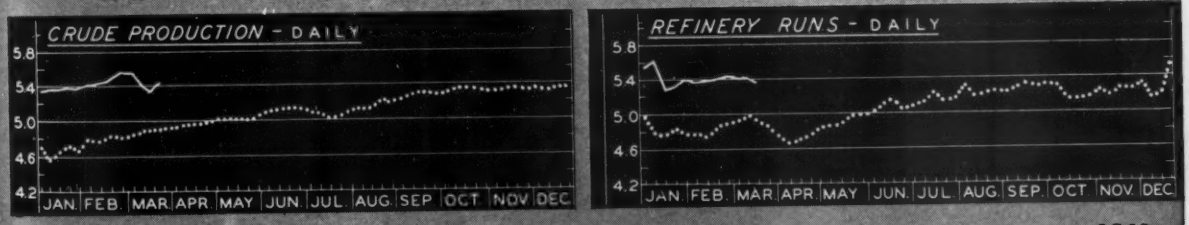
STOCKS IN UNITED STATES

---- 1947 ——— 1948



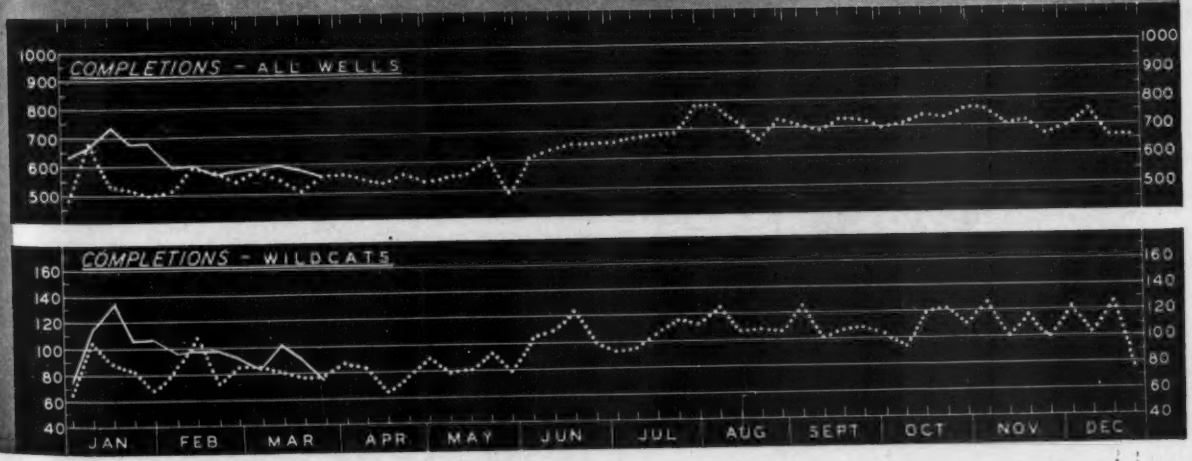
DAILY OPERATIONS

---- 1947 ——— 1948



WEEKLY COMPLETIONS

---- 1947 ——— 1948



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MARKETS

GASOLINE was described last week in the Oklahoma area as moving nearly entirely on a contract basis. Spot shipments were extremely few and demand for gasoline, while active, had not reached the high peak that is expected to begin soon. In East Texas some spot sales were reported as ranging between 11 and 12 cents.

Those spot buyers who in the past had done all their buying of products on the open market and did not have contracts with suppliers were reported to be experiencing difficulty in obtaining even a small amount of desired products.

No. 6 was reported as remaining "fairly soft" in the Mid-Continent area. One shipper said that any further change in the price level of No. 6 is being curtailed because of the uncertainty of the termination of the soft coal strike. One marketer said that the coal strike has not yet caused any appreciable effect on No. 6, but if the strike is extended for any length of time the heavy-oils market may be affected considerably.

No. 6 at $2.75

One buyer said that he could obtain No. 6 at $2.75 per barrel and even at that price he would not buy any amount of it unless he knew where he could dispose of it readily.

The tank-car situation was reported improving and there was an evident easing in the availability of cars which was probably due to the good weather that has prevailed in the past week and which has made faster turnarounds possible. Also, the transition from the light shipments of the winter burning-season oils to the not-yet-heavy shipments of gasoline has brought about a "lull" in products movement.

The vast enlargement of storage facilities by several larger companies will be of great help in meeting the extremely heavy demand for the winter season of 1948-49, according to one observer who said, "Storage will not solve the supply situation for next heating season, but it will mean that the supply will be in better hands and a more equitable distribution of the material will be possible."

The big problem for Middle West suppliers will be in their meeting the needs of the farmers which are expected by nearly all sources to be heavy.

Crude Scale Wax Drops

One major supplier in the Mid-Continent area last week reduced 130-132 crude scale wax ¼ cent to 8 cents per pound. Lube oils were reported as remaining firm. Demand for natural gasoline remained strong and price levels unchanged.

Price ranges along the eastern seaboard remained generally unchanged. Despite the apparent slight easing of No. 2 oil, as reflected by the drop in open New York market asking prices from 14.5 cents to 12 cents per gallon in the past 2 weeks, several independent suppliers said that they had been approached by major companies looking for spot heating oil material on either a cash or loan basis.

Retail suppliers in the New York area were reported indicating possible price reductions in their heating oils schedules but were waiting for still further softening in spot prices before making any changes.

Esso Standard Oil Co. early this week announced immediate price reductions on more than 350 of its products. Among those affected are farm tractor fuel, liquid petroleum gases, roofing asphalts, and oils and greases. A summer "fillup" discount of 0.7 of a cent per gallon on kerosine and home heating oils is offered by Esso.

Representative Quotations

Representative spot-market quotations of leading suppliers as of March 29, 1948. **Figures are f.o.b. plant for tank-car shipment in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.**

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor	Texas Gulf Coast
Regular gasoline, 73-75 octane	10½-11½	11.6-12* 10.5-12.2†	10.9-12
Premium gasoline, 78-80 octane	11¾-12½	10.6-13.4	12.9-13
42-44 w.w. kerosine	10-10½	10.2-12.2	10¼-13
No. 2 straw fuel oil	9½-11	9.3-11.1	9.05-11½
No. 6 residual	$2.50-3.00	$3.03-3.90	$2.56-3.00

*Branded (74-76 octane); †Unbranded (74-76 octane).

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	8½	8	8¼
Grade 18-55	10.2	9.6	9.9

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	13-14.5
750 vis., No. 3-4 neutral	15-17.25
2,000 No. 5-6 neutral	17-18½

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	30-33
200 vis. No. 3 neutral, 0-10 pp.	20-21

Western Pennsylvania

145-155 vis. 10 p.t. bright stock	47
180 vis. p.t. neutral	45

CRUDE-SCALE WAX

Mid-Continent

130-132 A.S.T.M. melting point	8-8½

EQUIPMENT MEN ... in the News

Rathbone Named Vice President

W. V. Rathbone will assume the position of vice president with Parkersburg Rig & Reel Co., effective April 1. His duties will be connected with the manufacturing division of the business. Rathbone is a native of Parkersburg, W. Va., and was graduated from Lehigh University with a degree in chemical engineering in 1926. After graduation he was employed by Parkersburg Rig & Reel Co.

In 1928 he left to accept a position in the research laboratories of Standard Oil Co., at Baton Rouge. He was later transferred to the Parkersburg refinery of Standard Oil Co. of New Jersey.

In 1941 he was appointed to serve as special expediter for his company in the government synthetic program. After the war he was appointed assistant sales manager of the Standard Alcohol Co., an affiliate of Esso Standard Oil Co. In August 1947 he was promoted to the position of manager of alcohol and chemical sales of Enjay Co., Inc., Esso Standard's marketing organization for chemical byproducts from petroleum, which position he filled until joining Parkersburg Rig & Reel Co.

Lowther Moves to Joliet

Harry A. Lowther Co., Inc., gains added plant and office space for its expanding production program with its move into a recently acquired plant on Industry Avenue, Joliet, Ill.

This move also brings about the centralization of all company activities. The large building in Joliet now houses the company administration and warehouse formerly located in Chicago, and the manufacturing operations previously carried on in Winona, Minn. Extensive tests of the new equipment will also be made possible at the new factory location in Joliet.

Leitch Visits U. S.

James M. Leitch, Eastern Hemisphere representative for Continental Supply Co., is scheduled to arrive in New York from London around April 5 for a 2-month visit. While here he will make a study of new methods and equipment and visit the International Petroleum Exposition and Congress at Tulsa.

Harder On South American Trip

James B. Harder, foreign representative of Reed Roller Bit Co., Houston is on a 4-month trip to Venezuela, Peru, and Ecuador. Harder spent part of 1946 and 1947 working out of the company's London office in Europe, North Africa, and the Middle East.

Anne Named Sales Manager

John W. Anne has been appointed sales manager of the Jeannette plant of Elliott Co. He came with the Elliott Co. in 1925 immediately after graduating as a mechanical engineer from Penn State. After completing his apprentice course, he was assigned to the condenser department. He became manager of the heat-transfer and turbine-sales department 5 years ago.

Robbins Named New Board Member

George W. Robbins has been appointed to the board of directors of Ultra-Violet products, Inc., Los Angeles.

Robbins is associate professor of marketing at U.C.L.A. He is a graduate of that school and also Harvard School of Business Administration. Previous to his present position, Robbins instructed at University of Oregon.

Other members of the board of directors include James A. Blaisdell, Collis H. Holliday, J. Leslie Goodson, I. R. Pfister, Henry Warren, and Thomas S. Warren.

Rope Sales to Ball & Black

A. Leschen & Sons Rope Co., St. Louis, announces that effective April 1 its entire line of oil-field wire ropes will be distributed in California by the new firm of Ball & Black Supply Co., 2439 Hunter Street, Los Angeles.

This firm is composed of two experienced wire-rope men, well known throughout the territory they will serve. These two men are C. R. (Chuck) Ball and C. H. (Clif) Black. Ball has been identified with the California oil fields for about 20

Plant managers from the 16 divisions and subsidiaries of Rockwell Manufacturing Co. have just completed their winter meeting at the home offices in Pittsburgh. Attending the meeting were: front row—W. S. Potter; W. H. Newbaker; A. J. Kerr; W. F. Rockwell; W. F. Rockwell, Jr.; E. W. Meyers; C. A. Wiken, all of the Rockwell Pittsburgh office; second row—H. C. Stuckeman, Delta Manufacturing Co.; J. E. Ashman, R.M.C., Pittsburgh; H. S. Rockwell, Hopewell Division; A. E. McIntyre, R.M.C., Pittsburgh; B. C. Trueblood, Arcade Manufacturing Co.; W. R. Brown, Arcade Manufacturing Co.; A. R. Whittaker, National Meter Division; C. H. Daugherty, Monessen Foundry & Machine Co.; third row—R. G. Caouette, R.M.C., Pittsburgh; N. J. Kenny, Ohmer Corp.; A. E. Higgins, R.I.C.; L. W. Heavner, Macnick Division; R. C. DuBruoq, Crescent Machine Co.; E. F. Foubart, R.M.C., Pittsburgh; fourth row—H. C. Greene, R.M.C., Pittsburgh; W. F. Crawford, Edward Valves, Inc.; Floyd Snodgrass, Nordstrom Valve Co., Oakland; William A. Marsteller, R.M.C., Pittsburgh; C. S. Bygate, R.M.C., Pittsburgh; L. A. Dixon, Jr., Pittsburgh Du Bois Co.

years, while Black has been active in the California fields for 25 years, and prior to that he spent a good many years in the Mid-Continent area.

A. Leschen & Sons Rope Co. also announces that it has, recently established a warehouse at 2439 Hunter Street, Los Angeles, where a complete stock of oil-field ropes is being carried.

Personnel Changes in Bethlehem Supply

Bethlehem Supply Co., Tulsa, announces the transfer of T. H. Gibbs to special representative in its Houston sales office. "Ty" Gibbs was formerly field engineer with Bethlehem Steel Co.

I. N. Hall, formerly assistant store manager at Alice, Tex., has been transferred and promoted to store manager and field representative at the Corpus Christi store.

R. P. Carpenter, formerly field representative at McAllen, Tex., has been transferred to Alice, in the same capacity.

S. I. Snyder has been promoted to field representative at the Harvey, La., store.

New employes who have recently joined Bethlehem Supply Co. are J. W. Jillson, special representative; Joe Chastain, engineering representative; and W. M. Bartlett, field representative, all of whom are at Odessa, Tex; Melvin Bates, field representative at the Craig, Colo., store; and R. M. Berman, special representative in the refinery sales department in Tulsa. Berman, a graduate of University of Texas in chemical engineering, was formerly employed by Hercules Powder Co. at Wilmington, Del., for 7 years prior to his becoming affiliated with Bethlehem Supply Co.

Tuboscope Expands To West Texas

Tuboscope division of Tubular Service & Engineering Co., Houston, has established a plastic coating service for drill pipe in the West Texas district.

C. E. Luna, formerly West Texas district manager for Tuboscope, has been appointed manager of the new plastic-coating service department.

The company is applying a thermoplastic developed by Tube-Kote, Inc., which has proved extremely successful in resisting drill-pipe corrosion.

ACF Appoints Schuster

Announcement is made by American Car & Foundry Co., New York, that William H. Schuster has been appointed welding supervisor for the company. Schuster comes to A.C.F. with a wide and varied experience as a welding engineer.

Oil Well Supply Names Irwin

John C. Irwin, 36, an attorney for the United States Steel Corp. of Delaware, has been named secretary

J. C. IRWIN

F. L. WIEGAND, Jr.

and general attorney for Oil Well Supply Co.

He succeeds Frank L. Wiegand, Jr., secretary and general attorney since 1945, who resigned to assume a similar position with National Tube Co., another subsidiary.

For the present the new Oil Well officer will remain in Pittsburgh, but will move to Dallas in the course of the next few months.

Sawtelle Appointed Export Manager

Hinderliter Tool Co. Division of H. K. Porter Co., Inc., announces the appointment of J. E. Sawtelle as manager of the export division. Sawtelle will be located at the offices of H. K. Porter Co., Inc., 50 Church Street, New York.

A graduate of Rice Institute, Sawtelle worked for Creole Petroleum Corp. in Venezuela for several years. Returning to the United States, he worked for the Baker Oil Tools, Inc., as a sales engineer, until the outbreak of World War II.

He entered the United States Army as a private in 1941 and was released in February 1946 as a major, having served as aide de camp to Lt. Gen. A. M. Patch, commander of the Seventh Army.

Rockwell President Honored

W. F. Rockwell, Jr., president of Rockwell Manufacturing Co., Pittsburgh, has been elected to the board of directors of the Pennsylvania State Chamber of Commerce. Rockwell has also been appointed to the legislative advisory subcommittee for the World Trade Council as sponsored by the Chamber of Commerce, Pittsburgh.

Moore to Make Survey Trip

Art Moore, vice president in charge of sales, Oil Base, Inc., has scheduled a 6-week trip which will take him to Houston, Midland, New Orleans, Mississippi, Dallas, Oklahoma City, Tulsa, and Denver. Moore plans to attend the A.A.P.G. annual meeting to be held April 26-29 in Denver, where Oil Base, Inc., will exhibit its products. Moore will return to the home office in Compton, Calif., early in May.

Transfers in Continental Supply

G. N. Frost, former field salesman for Continental Supply Co., at Brookhaven, Miss., has been appointed store manager at the same location, succeeding J. R. Osteen. The latter has been transferred to Shreveport as store manager.

Guy W. Bigham, Continental's former store manager at Shreveport, has been transferred to Shreveport district office as district sales representative.

Huntress Named Rope Sales Manager

R. G. Huntress has been appointed manager of wire rope sales for California Wire Cloth Corp., a subsidiary of Colorado Fuel & Iron Corp. Huntress graduated from Wentworth Institute in Boston. He joined Wickwire Spencer Steel Division in 1937 and has held the positions of assistant to the superintendent of the wire rope mill at Palmer, Mass., and later wire rope sales engineer. During World War II, he served with the United States Navy. He will operate out of the Oakland, Calif., office to serve the Pacific Coast area.

Changes in Branch Personnel

International Harvester Co., motor-truck division announces the following change in branch personnel:

M. F. Williams, formerly retail manager at the Wichita, Kans., motor-truck branch, has been transferred to the San Antonio truck branch as assistant manager.

F. C. Mayer, formerly retail manager at the Birmingham motor-truck branch, has been appointed assistant manager at the Charlotte, N. C., motor-truck branch.

Barker Elected to Board

James M. Barker of Chicago, chairman of the boards of Allstate Insurance Co. and Allstate Fire Insurance Co., has been elected to the board of directors of Allis-Chalmers Manufacturing Co., Milwaukee. Barker replaces Alfred J. Kieckhefer, president of National Enamel & Stamping Co. of Milwaukee, who resigned.

W. A. Roberts and W. C. Johnson, executive vice presidents of Allis-Chalmers, have been appointed to the executive committee of the board. They replace Kieckhefer and the late Herman W. Falk.

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